SHOP LAYOUT: A GUIDELINE TO DUCT SHOP MANAGEMENT

SMACNA
Sheet Metal and Air Conditioning Contractors' National Association

SHOP LAYOUT

A Guideline to Duct Shop Management

By

James L. Segroves

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Prepared under the direction of the SMACNA Business Management Education Committee

SHEET METAL AND AIR CONDITIONING CONTRACTORS' NATIONAL ASSOCIATION

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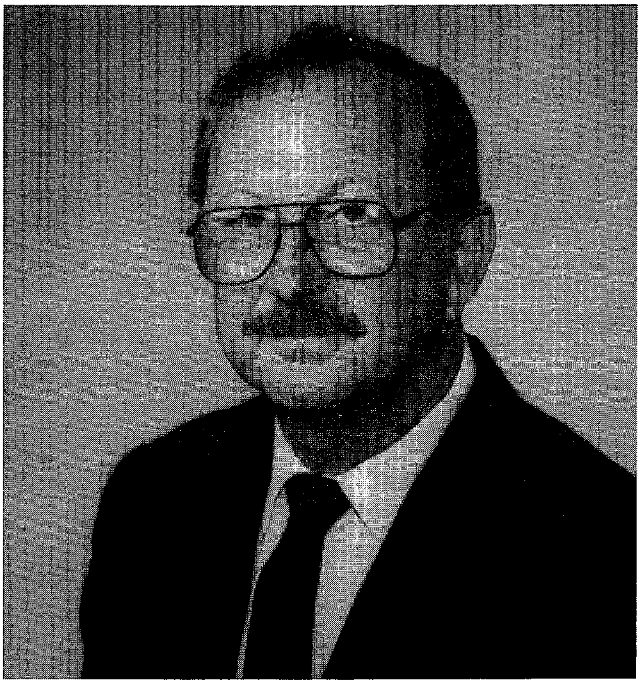
INTRODUCTION

The information presented in this publication is printed from Chapter 2 of the widely-distributed Sheetmetal Operations manual by James L. Segroves and represents over 14 years of research and documentation in an ongoing quest for better shop management guidelines. The "basics" of good shop management include such important areas as data preparation, time recording, job descriptions, and the critical concept of equipment arrangement and work flow path.

Due to the range of variances in traditional fabrication methods as dictated by local requirements, as well as the subsequent lack of standardization, not all of the guidelines suggested herein will work in all shops, but with reasonable effort and some degree of adaptation, most of them will. My experiences have shown that the key to success in improving shop efficiency lies in an enthusiastic management/labor team effort, and the results are mutually beneficial.



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In addition to running his Dallas-based consulting firm, Mr. Segroves enjoys a background of over 25 years in the sheetmetal industry. Award-winning innovations led to his supervising some of the largest sheetmetal operations in the Southwest. In his numerous consulting jobs across the United States and throughout Europe, Canada, England, Australia, and the Middle East, Segroves' methods increased production up to 30%.

SHOP LAYOUT

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Management Structure and Responsibility

Overall Organization/Structure

- Department head - General Superintendent
- Outside erection - Outside Superintendent
- Shop production - Shop Foreman
- Detail work and shop drawings - Detailer
- Job foreman on each large job

Responsibility Assignments of Supervisors and Foremen

Department Head

1) Begin work day at shop before shop and field start.

2) Dispatch truck driver to any hot deliveries before work time.

3) Begin taking incoming phone calls from:

Job foreman about job progress, special problems, personnel problems and any problems that the outside foreman has not resolved.

Customers concerning new jobs that do not require engineers' help, such as sheet metal flashings or modifying existing ductwork on small jobs. This is rather subjective and should be coordinated with other departments.

Construction superintendents about scheduling, complaints, etc.

Vendors calling to discuss shipment schedules of grilles, etc.

4) Go over new lease prints with whoever is going to do the work. This is usually a mechanic who is trained and equipped to do small leases and can therefore keep the cost to a minimum. It is recommended that the man chosen for this type of job be a good all-around sheet-metal man who can take care of leases and medium, small, and hot jobs. He should also be able to get along with customers well. A well-equipped van is quite valuable for this application.

5) Verify time cards, go over job numbers, and work codes on outside time sheets from field. Hold field time sheets until shop foreman goes over shop time and gives it to him; then turn in all time to payroll department.

6) Go over stock sheets and material requisitions turned in by shop foreman and forward them to the accounting department.

7) Go over purchase orders that were made out by shop foreman and forward them to the purchasing agent.

8) Communicate with shop foreman about production schedules on work to be run through the shop and about shipping dates, etc.

9) Communicate with outside superintendent about job progress, schedules, special problems, material needed, personnel, problems on outside superintendent's reports on new jobs coming out of ground so they can consider items such as concrete sleeves, underground duct, etc.

10) Go over job costs/estimates with outside superintendent and shop foreman and question or reaffirm as required.

11) Communicate with engineering department about scheduling of new and exsiting jobs. Encourage the

earliest possible release time of prints on new jobs so the sheetmetal department can formulate an effective production and erection schedule, thus eliminating late starts and unnecessary expenses such as modifying ductwork on job sites and overtime in the shop and on the job.

12) Coordinate delivery and shipment of equipment and material to the jobs and any rigging required.

13) Communicate with engineering department about proper material, procedure, and pricing of jobs not covered by regular estimate.

EXAMPLE: Boiler breechings, special roof flashings, hole cutting, removal of existing systems' special fabrication costs in the shop.

14) Make an inspection tour of field every few days, or whenever special problems arise that the outside superintendent cannot handle.

Outside Superintendent

1) Begin work day at shop 1 hour before work time.

2) Go over fittings and drawings brought in from previous day with department superintendent and detail man, checking to make sure fittings are not choked and are of proper design.

3) Go over hot jobs with detail man and shop foreman and discuss scheduling, delivery, ordering, etc.

4) Report each morning to department superintendent about daily progress of jobs and what should be looked at.

5) Try to make all job sites daily and do all measuring of unit hook ups and duct changes if possible. If a job

foreman does any measuring, it is a good idea for the outside superintendent to go over each ticket with that job foreman before bringing it to the shop for final inspection by the department superintendent. Everyone must keep in mind the danger involved in making bad fittings (such as choke fittings, dogleg fittings, quick offset fittings, double ells, etc).

6) Coordinate special events between the shop and the field (such as rigging and equipment delivery).

7) Regulate the transition of personnel between jobs as they are started or completed.

8) Recommend to the department superintendent the hiring or layoff of outside people as required.

9) See that the proper tools and materials are delivered to new jobs so that when workmen arrive, they can proceed to work without delay.

Field Foremen

1) Let shop manager know if any special tools are needed to speed erection.

2) All work brought in from field must go through shop foreman for scheduling.

3) Field should give maximum lead time on work sent in so it can be scheduled.

4) Send drawings of duct rather than call them in.

5) Field supervisors should go directly to the job every morning.

6) All supervisors should define responsibilities to new employees.

7) Field supervisors should make their own punch list about 3 weeks before completion of large jobs, and send a copy to the department manager.

8) Field supervisors should communicate on any problems with shop fabrication.

9) Field supervisors should line out work for crews as far ahead as possible.

10) Minimum amount of duct should be fabricated at the job site.

Shop Foreman

1) Start work day 1 to 1½ hours before shop starts to work; it is important and helpful to get all of the paperwork from the previous day out of the way. Also, time cards should be checked and given to the department superintendent. Early arrival also gives the shop foreman a chance to walk through the shop when it is quiet and look at the work in progress. This is an ideal time for him to consider such things as quality control, job progress, fabrication methods used, material stock, and innovations to expedite work.

2) Turn in stock sheets to department superintendent, being sure to look them over for proper quantities and proper job number. Pay special attention to material charged to work orders and service orders. Set up a file and keep copies of any material charged out that is questionable.

3) Turn in all completed purchase orders with receiving slips. This includes control copy, file copy, and the receiving slip itself.

4) Issue all purchase orders for all material needed by the shop or requested for the field by the outside superintendent or department superintendent. This includes

issuing purchase orders for rigging, equipment rental, equipment repairs, purchases of small tools. If the purchase is over $100.00, it must be approved by the purchasing agent. Issuing a purchase order includes locating and ordering the material or services involved.

5) Supervise repair and maintenance of all shop equipment. This includes overseeing the routine maintenance and greasing of all shop equipment. It is good to have one good serviceman to do both the routine maintenance and the repair work on the shop equipment. **Never let sheetmetal mechanics do repair work on the equipment.** It is too expensive and tends to hinder production.

6) Supervise flow of hot jobs through the shop. Try to keep a good all-around mechanic in the shop that can cut, form, insulate, and assemble an array of duct. He must be fairly fast at all procedures in order to hold the costs down. He must be diplomatic with other workers in the shop in order to work his fittings through.

7) Supervise flow of large regular contract work through the shop. This is the backbone of the operation. It is very important that once a large job is started, a flow of finished work is induced from the shop. Usually what determines the cost of the shop fabrication of a job is the continuity of this flow and the frequency of interruptions. Most interruption can be avoided by working hot and small jobs through as described in the previous paragraph. A shop team to do large contract work will normally consist of a shear man, a good, fast cutter, a brake man, a ductliner cutter, a spray and pin man, and assemblers.

8) Foreman's routine for the flow of cutting tickets through the shop is as follows:

a) All new tickets go to a clipboard marked **New Tickets** as soon as they are received from the ticket maker (detail man).

b) New tickets go from **New Ticket** board to the shear man so that blank pieces can be sheared out. They are then returned to a clipboard marked **Thru Shear.** An occasional glance at this clipboard gives a good indication of how much work is ready for the cutter, and at this point, you can begin to consider scheduling.

c) Tickets now go from **Thru Shear** to cutter to be cut, then back to a clipboard marked **Thru Cutter** where they are held for reference until work is through the shop and delivered for the job. A file cabinet is a necessity for the shop foreman to file old tickets and keep copies of special fabrication items.

Management Summary

Here are some of the most important points of which respective supervisors should be aware:

- job specifications and/or SMACNA
- fittings measured on job site should be checked for proper design
- ductliner application and number of pins used (especially on high velocity ductwork) - check for fuzz strips when required
- type of connectors used on ductwork
- overloading shop and/or jobs with unnecessary people
- short and long term job and production scheduling
- proper design and material must be used in boiler breechings and grease hood exhaust ducts

- communicate as much as possible with department heads about new and existing work
- schedule maintenance of shop equipment by a serviceman
- proper charging of material and labor
- proper receiving of material at shop or job/proper follow up of paper work
- keep decision-making at lower levels at an absolute minimum - don't let regular sheetmetal workers make decisions that can be made by superintendents and department heads
- supply proper tools to workers and see that they use them effectively
- by proper coordination and scheduling, virtually all overtime in the shop and the field can be eliminated
- keep in mind OSHA regulations when buying tools and also consider safety when looking at the shop operation

Guidelines to a More Efficient Sheetmetal Operation

1) Train your detailer with the best detailing methods possible.

2) Rearrange the shop equipment for better work flow.

3) Install new equipment as required.

4) Consider new material as required.

5) Analyze erection and field measuring procedures.

6) Analyze shop methods for improvement.

7) Establish basic shop production systems that will enable the shop to

   a) produce maximum volume at the least cost/lb; and

   b) provide a more systematic production system that will eliminate lost time and motion of regular shop men as well as field men who come in during the day.

8) Shop should look and sound busy, no matter how many or how few people are in the shop at any given time.

9) An ample supply of work tickets should be kept ahead at all times.

10) Work through shop should be fabricated on a station-to-station basis (one man, one job). Under extremely slow work loads, one man should work at several stations.

11) Men that walk into the shop during the day should be confronted with an ample supply of work at one or more stations - this will eliminate lost time.

Shop Drawings, Detailing, and Shop Ticketing

Most larger jobs should be redrawn from the original mechanical drawings, in order to produce drawings that are more relative to your shop fabrication methods. This will allow the draftsman to simplify the duct design and eliminate costly complex fittings. Another very important advantage to redrawing the plans is that the draftsman can lay the duct out with consideration given to the width of the flat sheets that will be used in fabrication. For example, fittings and straight duct can be drawn to best conform to the flat sheets in stock. Also, the transitions can be "floating length" to allow the long side's length not to exceed the width of the material in stock. At present, this width is 48", but when a wider stock is obtained, it will be a big advantage to use 60" wide sheets as standard.

The most common mistake when making shop drawings is to put too much precise detail on the drawings. This practice not only adds to the already expensive cost of shop drawings, but it also can delay the shop production schedule and therefore throw the entire job behind.

Equipment rooms should be redrawn to only show a general route and the configuration of the duct involved. This will give the person that measures up the equipment rooms a good idea of what to work to. If there are any major changes in the equipment room layout, then it should be redrawn again.

NOTE: Most shop drawings will need to be submitted to the design engineer for approval. This also can be beneficial to the contractor, as it will present the opportunity to show the advantages of a simplified duct design.

Shop Data Systems Detailer Methods

The primary concept of the Shop Data Systems detailing method is to move the decision-making process from shop and field personnel into the detailer's office. The only way this can be done is to put as much information on all shop tickets as possible. Some information is quite easily obtained, such as that required for shearing straight duct. Other data is much more difficult and time-consuming, and requires a great deal of concentration. Accuracy is the key to successful detailing, along with thoroughness. In short, this is the most important aspect of implementing an efficient production system.

Responsibilities of Detail Man

1) Receive new job prints from his department head.

2) Look over prints and stamp with the three appropriate stamps and note date received.

3) Read job specs for fabrication.

4) Ductwork piece tag numbers should always be put on the tracing or sepia by the draftsman. Number each joint and fitting starting at any logical place with number 1 and ascending in order. Number full straight duct joints

using common numbers or common sizes of the same gauge. Indicate the unit and floor that the pieces are to be installed on. Also, a print should be numbered for field use.

5) If you are not producing computerized shop tickets, then manually make tickets for fittings showing exact stretch out of runners, tops, bottoms, wrappers, etc. Most of this can be done using a few basic sheetmetal formulas. This same procedure should be used for hot job and large job tickets.

6) Make tickets for straight duct listing each piece by number and giving exact sheet size.

7) Make a list of liner to be cut to go with straight duct. Fittings do not usually need a liner list.

8) Make a list of connectors and hangers required and list them by unit and job.

9) Take off special fabrication items giving all dimensions and information required to expedite them through the shop.

10) Take off and list all material to be ordered and give this list to the shop foreman or purchasing agent.

11) Take orders for fittings and material from field only when they cannot be sent in through the outside superintendent. Verify these orders with the department superintendent or outside superintendent whenever possible.

12) Serve as backup man for shop foreman so that when he is unreachable, the shop will not be without someone to oversee the work in progress.

Detailer's Notes

1) Put all mathematical data on shop tickets.

2) Keep as many tickets made ahead of time as possible.

3) Make ductliner list after listing straight duct.

4) Start ductliner, connectors, vanes, spin tabs, etc. as soon as possible.

5) Be sure to start the shear man and cutter or plasma machine operator on the next control zone before the one in process is completed. This is very important as it will prevent the workflow from being broken by not having more work ready to form, insulate, and assemble after the last load is shipped.

6) Do whatever is necessary to meet your production schedule. If needed, extra men can be used at any station, such as forming or assembly.

Flow Control with Clipboard Rotation

1) Place new cutting tickets on clipboard marked **NEW TICKETS.**

2) Give new tickets to shear man or plasma machine operator.

3) After shearing, place on clipboard marked **THRU SHEAR** or **THRU PLASMA.**

4) Give tickets to fitting cutter as required.

5) After cutting, place on clipboard marked **THRU CUTTER** or **THRU PLASMA.**

6) After forming and assembly, place in job file by job number.

Shop Management Filing System

An efficient shop filing system is vital to having a smoothly run shop, and it can also eliminate much frustration for the shop foreman and purchasing agent. Files should be set up as follows:

1) Job file for each large job (more than one week to fabricate)

2) File for **Special Fabrication Items**

3) File for shop materials and supplies (showing vendors)

4) File or basket for small orders and hot jobs

5) File for equipment, tools, parts

6) File for completed and pending purchase orders

Shop Work Flow

Team Concept

The duct fabrication operation is divided into six stages:

Detailing, Shearing, Cutting, Forming, Insulation (ductliner), Assembly

- Detailing - the heaviest responsibility lies at this point. The detailer must keep a very substantial quantity of tickets in reserve. Usually it is necessary to have a backup man for peak periods. It is absolutely imperative that all pertinent data be listed on cutting tickets (i.e. shear, blank sizes, radius points, ductliner lists, connector lists, metal gauges, ID numbers, special instructions). A good plasma computer system will automatically provide all shop lists.

NOTE: Computer listings can greatly relieve the pressure at this station and also ensure that there are no mistakes in computation.

- Shearing - the shear man, above all, must be quick and accurate. He must be very good at manipulating numbers and shearing configurations in his head in order to generate the best cuts from his shearing stock. A good shear man can keep a fast cutter well-supplied with blanks and also do all shearing for hot jobs (he should be able to supply blanks for two cutters).

A plasma cutting machine will eliminate most manual shearing and layout.

- Cutting - During the process of cutting fittings, the layout will normally extend from edge to edge of the sheared blank (except on drop cheek elbows there will be some extra material). This will provide an automatic check system to ensure that the detailer, shear man, and cutter are all interpreting the fitting the same way. No mathematical checking should be done except by the detailer with his electronic calculator. This is an example of the rare occasion when assumption is proper; therefore, the shear man and cutter should assume the shear list data is correct and proceed with the job.

  If for any reason the fitting cutting is interrupted, the cutter should fill in at the forming station, as he has cut the fittings and is familiar with them.

- Forming - this should primarily be done by people who are shop-oriented, although some erection men can do this if they are familiar with the shop equipment and need some fill-in work. Considerable concentration is required so that the pieces will be formed properly, as mistakes at this point create lost time, labor, and material.

- Insulation - the ductliner operation is the least desirable of all shop work, although as much or more profits can be made here than in any other phase. This worker must keep a substantial stockpile of pieces cut in order to ensure the continuity of the work flow. It is most important also to properly mark the pieces, before stockpiling, so that he can match the ductliner pieces with the proper duct as it becomes ready to line.

Always mark by joint or fitting number as reflected on prints used for detailing.

- Assembly - this being the final stage of production, the work done at this point can be used to employ persons that are perhaps only in the shop occasionally, or those who are normally working at another stage of the work flow. This activity provides the type of work that anyone can participate in and be effective without others being directly dependent on their output.

General Notes

The team concept actually means that each individual depends upon the stockpile of work that is produced by the man immediately preceding him in the work flow. Soon after implementing this concept, the shop foreman will become very adept at judging exactly how to distribute the labor between each station in order to produce the smoothest work flow possible. (It is often necessary to place more than one man at a station, particularly when completing a control zone on schedule.)

Primary Job Processing

Primary job processing is simply a term used to define the main job that is being processed through the shop at any given time. These larger jobs should be processed and delivered to the job site in sections, designated as **control zones**. Sometimes it is necessary to process a control zone from one job and then process a control zone from another job; this is when there are two or more large jobs that must be kept in constant supply of duct at the same time. The important thing is that a complete zone be finished before another is started through. This will avoid confusion in the shop and ensure that the men in the field will receive complete shipments and thus prevent their jumping from one area to another and leaving loose ends all over the job. A control zone is not complete until all parts of it are ready, including all connectors, hangers, taps, flex connections, etc.

NOTE: By processing in control zones and by using the team concept, it is possible to become very adept at implementing and meeting production schedules. This is actually the goal that the shop supervisors must work toward in order to have a profitable shop operation.

Hot Second Job Processing

It is very important that hot jobs be processed through a systematic program to ensure that they will go through quickly and will not cause disruption of the primary (large) job that is being processed. This can be accomplished by working in the following order:

1) Hot jobs should first go through the shop foreman to be detailed.

2) After detailing, they should be given to the shear man for shearing.

3) If a man brought the work in from the field, he can be working at one of the less committing stations in the work flow, such as forming or assembly. This will greatly reduce lost motion in the shop. If the primary job is running on a tight schedule, it may be necessary for the man that brought it in to work the job up by himself after it has been sheared. Extreme caution should be used here so as not to interfere with the primary job.

Duct Assembly Operation

All straight duct and fittings for small or hot jobs should be done in the shop. An area with a wooden top table should be designated for this near the loading door.

By using the new system of shop fabrication, the fittings can be completely assembled in the shop. It is very important that the turning vanes for elbows be ready and waiting at the assembly table.

All fittings should be put completely together in the shop for big jobs. Duct for big jobs will generally be shipped unassembled. The new tag numbering system will eliminate job site assembly problems of straight duct sections.

NOTE: The new numeric numbering system will also improve the assembly of fittings.

Shipping Guidelines

The implementation of efficient shipping procedures is one of the most important aspects of a sheetmetal operation. Both the shop and field depend on timely, complete, and efficient delivery of the ductwork, tools, and equipment to the job site. Without effective shipping methods, erection costs can be affected, valuable shop floor space can be tied up, and pieces can be scattered or misplaced, resulting in incomplete shipments.

The following guidelines represents some of the most critical areas to be considered for shipping efficiency.

The Printed Shipping List

A hardcopy (printed) shipping list is a basic requirement for efficient shipping. These lists can be produced by hand, but most shops use computer-generated shipping lists (usually as a spinoff of computerized shop ticketing or from a plasma cutting machine office system).

The format of the shipping list is critical. It must be very condensed and precise so as to allow the loader to quickly match up the printed description with the item to be shipped. There is, in reality, a very thin line between a good shipping list format and an inefficient format.

A shipping list that is formatted properly can serve several important functions. Primarily, it can assure that all pieces are, in fact, loaded on the truck or trailer so that the erection people will have complete units of work without suffering the costly consequences of missing ducts, fittings, or other components (such as connectors or hangers).

Secondly, the shipping list can serve as an effective quality-control instrument. For example, the format shown on the next page will allow the loader to confirm certain ductwork construction characteristics, including connectors, vanes, ductliner, dampers, and other attributes.

```
Page #1                  ***Shipping List***          Date: 01-30-1989
-----------------------------------------------------------------------


Job #                                Fitting Number & Description
Floor           Tag #     Qty        End Dimension & Connector
-----------------------------------------------------------------------
Test #158                            F - (BLANK)  *STRAIGHT DUCT*
Mezz #12        1         1          End 1 - 36.00 x 24.00 Slip & Drive
                                     End 2 -               Slip & Drive
                                     End  3 -
                                     End 4 -

                          RECORD #1
-----------------------------------------------------------------------
Test #158                            F5 - SQUARE TEE
Mezz #12        2         1          End 1 - 36.00 x 24.00 Slip & Drive
Liner - 1 1/2 inch - 3 lb            End 2 - 18.00 x 24.00  Slip & Drive
                                     End 3 - 16.00 x 24.00  Slip & Drive
                                     End 4 -

                          RECORD #2
-----------------------------------------------------------------------
Test #158                            F - (BLANK)  *STRAIGHT DUCT*
Mezz #12        3         1          End 1 - 18.00 x 24.00 Slip & Drive
                                     End 2 -               Slip & Drive
                                     End 3 -
                                     End 4 -

                          RECORD #3
-----------------------------------------------------------------------
Test #158                            F 74-OFFSETTING SQ TO ROUND
Mezz #12        4         1          End 1 - 18.00 x 24.00 Slip & Drive
                                     End 2 - 20.00 Raw
                                     End 3 -
                                     End 4 -

LENGTH - 44.76

                          RECORD #4
-----------------------------------------------------------------------
```

Load Logistics

There are advantages and disadvantages to the individual types of vehicles commonly used in shipping (such as closed or open semi-trailers and gooseneck trailers).

Closed semi-trailers provide protection from the weather but can become very inefficient if used for job site storage and the erection order does not correspond to the loading sequence relative to the rear of the trailer.

The Load Profile

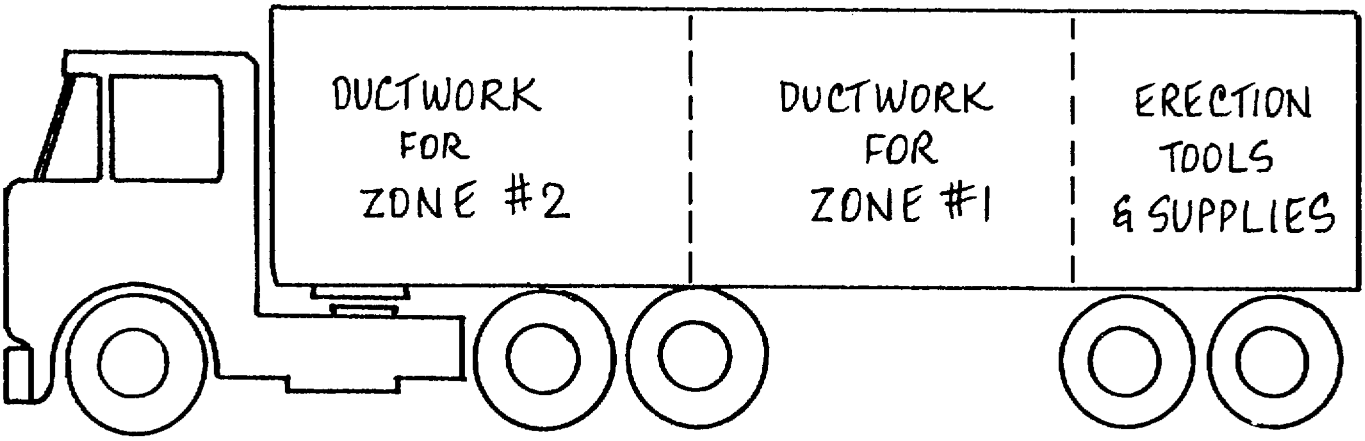
One concept that can be extremely beneficial to the field foremen is to provide a graphic representation of the truck or trailer contents showing exactly where the various duct zones or runs are located relative to the rear of the truck. This can best be done by providing a profile drawing of the loaded trailer as it would appear, looking at the driver's side of the truck. The side view drawing of the trailer can be reproduced from a blank master similar to the examples shown on the following pages.

LOAD PROFILE

JOB NO. 2386 ENERGY BUILDING

SHIPMENT DATE: JANUARY 15

LOADER: BOBBY RANDALL



NOTE: THIS IS A TYPICAL SAMPLE OF A COMPLETED LOAD PROFILE SHEET

FIGURE 26

LOAD PROFILE

JOB NO.

SHIPMENT DATE:

LOADER:

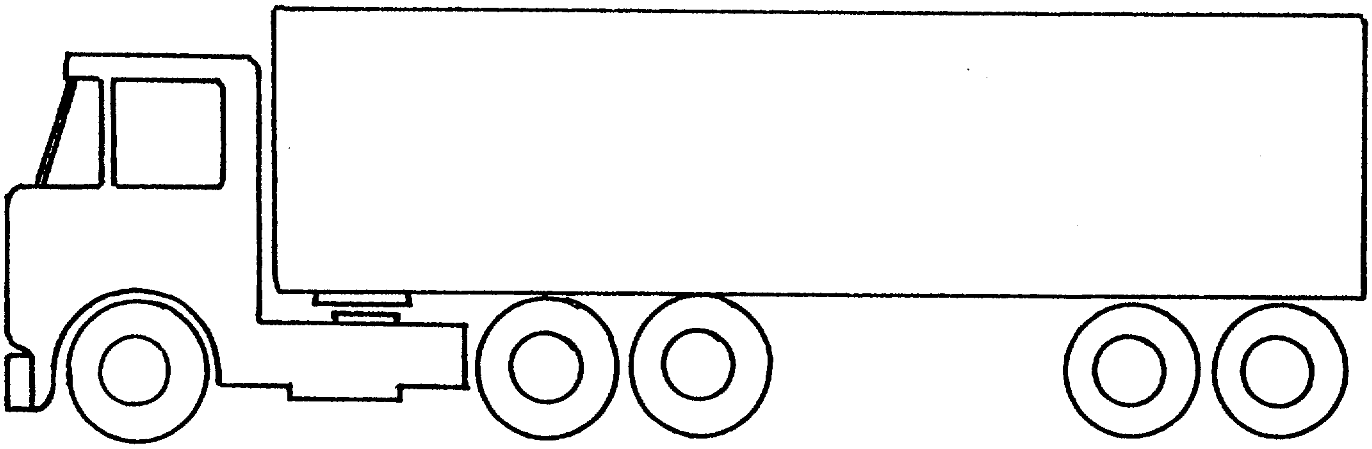


FIGURE 27 LOAD PROFILE SHEET

First Load Checklist

One of the most helpful concepts for upgrading the shipping operation is the implementation of the "First Load Checklist" (shown on the next page). Given that managers are dealing with an almost infinite number of variables related to the items that can be part of a routine sheetmetal shop shipment to the job site, and realizing the inherent limitations of the human memory, it is inevitable that problems are going to arise due to incomplete shipments to the job site. Especially on the first load going to a new job startup is this almost certain to occur. For example, it can be very costly to omit an item as basic as the duct hangers.

The following "First Load Checklist" should act as a basic guideline and can be easily user-modified to include any items normally shipped by your particular shop.

First Load Checklist

Job Name________________ Job Number_________
Loader__________________ Date______________

Req	Loaded	Req	Loaded
____	____Rectangle Duct	____	____Duct Sealer
____	____Rectangle Fittings	____	____ Gang Box
___	____Rectangle Connec.	____	____Ladders
____	____Hangers	____	____Duct Tape
____	____Round Ducts	____	____Screws
____	____Round Fittings	____	____Anchors
____	____Round Connectors	____	____Extension Cords
____	____Supply Air Distrib	____	____Concrete Drill
____	____Return Air Distrib	____	____Drill Motors
____	____Sq to Round Grille Adaptors	____	____Blueprints
____	____Low Press Flex	____	____Shipping List
____	____High Press Flex	____	____Truck Loading Map
____	____Low Press Alum Flex	____	____Gas Vent Pipe
____	____Flex Bands	____	____Gas Vent Fittings
____	____Round Tapins	____	____Hilti Gun
____	____Roof Curbs	____	____Hilti Shots
____	____Flex Connections	____	____Fire Dampers
____	____Outside Goosenecks	____	____Fire Damper Sleeves
____	____Exhaust Hoods	____	____Smoke Dampers
____	____Outside Air Intake Hoods	____	____Access Doors
____	____Exhaust Ducts	____	____Internal Insulation
____	____Exhaust Fittings	____	____External Insulation
____	____Exhaust Grilles	____	____Staple Gun
____	____Duct Hoist	____	____Glue and Brushes
____	____Multi-Blade Control Dampers		

Use the Appropriate Vehicle

Finally, it is worth noting that the basic economics of day-to-day routine shipping dictate the necessity of using the appropriate vehicle for the size and type of load being shipped. It is prohibitively expensive to ship small payloads on heavy trucks, but many shops continue to do exactly that every day. An extreme example of this situation is when paychecks are delivered to the job site using something like a 2-ton stakebed truck.

General Guidelines for Work Flow Control

Interruptions are the primary cause of production problems in most shops. The most common interruptions to shop work flow are:

1) Improper or insufficient information on shop tickets.

2) More than one worker using a piece of equipment at the same time.

3) Excessive conversation between shop workers.

4) Not having the proper tools to work with.

5) Not having material needed.

6) Changing from one work station to another too often.

7) Too many non-employees in the shop (see note below).

8) Workers not understanding their part in the team concept.

9) Equipment breakdown (when no alternate means of processing is available).

10) Flow paths (aisles) are blocked or cluttered.

11) Finished duct is not being shipped out soon enough.

NOTE: To help eliminate unauthorized personnel from the shop area, place the following sign at the receiving door:
DO NOT ENTER! INSURANCE WILL NOT PERMIT VISITORS. GO TO FRONT.

The Team Concept and the Role it Plays

Each work station will represent a member of the team, beginning with the detailer and ending where the fittings are assembled at the shipping dock. When production schedules are slow, one man must operate at several stations. Normally each station will provide a reservoir of work for the next station downstream.

NOTE: Always keep work at several stations so the outside men that return in the middle of the day have immediate work.

Time Card Entries, Control Zones, & Shop Work Code Numbers

Efficient use of time card work code numbers is very difficult without use of a recording time clock; therefore, I strongly recommend using one. Please see Pages 2-34 through 2-38 for a listing of work code numbers and their applications.

Work Code Control with Time Clock System

I strongly recommend the use of a time clock to control the start/stop activities of the shop as well as for keeping a more accurate and efficient record of job and/or work code changes. A time clock not only projects a more business-like atmosphere, but it also pays for itself in a very short time in the form of savings on coffee/lunch periods.

Many models are available which punch and record time cards as well as signal start/stop activities.

Here's a good schedule to adhere to:

Buzz	7:58 am
Buzz	8:00 am
Buzz	10:00 am
Buzz	10:15 am
Buzz	12:00 Noon
Buzz	12:25 pm
Buzz	12:30 pm
Buzz	2:00 pm
Buzz	2:15 pm
Buzz	4:30 pm

Sheetmetal Work Codes (Shop Labor)

Shop Labor Management Numbers

#20	Shop Supervision (pure supervision by shop foreman)
#21	Shop Drawings (modify or redraw originals)
#22	Takeoff and Detailing (produce cutting tickets)
#23	Fitting Fabrication (includes sheared down straight joints)
#23 S	Fitting Shearing
#23 C	Fitting Layout and Cutting
#23 F	Fitting Edging and Forming
#23 V	Turning Vanes
#23 A	Fitting Assembly
#23 D	Fitting Dampers
#24	Straight Duct Fabrication (for full length joints)
#24 S	Straight Duct Shearing
#24 N	Straight Duct Notching
#24 X	Straight Duct Cross Breaking or Beading
#24 E	Straight Duct Edges (pitts or snap/lock)
#24 B	Straight Duct Forming or Bending
#24 C	Straight Duct Connector Ends

#25	Duct Liner
#25 **FC**	Fittings Liner Cutting
#25 **SC**	Straight Duct Liner Cutting
#25 **AF**	Applying Glue and Liner to Fittings
#25 **AS**	Applying Glue and Liner to Straight Duct
#25 **P**	Applying Pins
#26	Connectors
#27	Truck Load, Unload, Delivery
#28	Special Fabrication (includes auto dampers, louvers, black iron, etc)
#29	Architectural Sheetmetal (includes gutter, facia, gravel guard, etc)

Shop Labor Work Codes (Time Clock)

To be posted at time clock

#23	Fitting Fabrication (includes sheared down straight joints)
#24	Straight Duct Fabrication (for full length joints)
#25	Duct Liner
#26	Connectors
#27	Truck Load, Unload, Delivery
#28	Special Fabrication (includes auto-dampers, louvers, black iron, etc)
#29	Architectural Sheetmetal (includes gutter, facia, gravel guards, etc)

1. Each shop worker will enter his name and the date on card before work is started each morning. Men from field will enter their name and the date before starting work in shop as they come in during the day. Everyone working in shop for any length of time must have a time card.

2. To begin work in shop:

- Insert card into time clock to record time.
- Write job number, zone, work code next to the time stamped on the card.

3. To change work in shop,new time must be recorded when job number, zone, and/or work code are changed.

4. To stop work at day's end or to return to field, record time with no new entries.

Sheetmetal Work Codes (Field Labor)

Field Labor

#27	Load, Unload, Delivery
#30	Field Supervision (pure supervision by field foreman)
#31	Distributing Duct to Floors or Areas on Job
#32	Duct Erection
#33	Alum Flex Duct
#34	Hi-Press Duct Sealing
#35	Hanging High to Low Pressure Boxes and Valves
#36	Special Erection (auto dampers, boiler breechings, louvers, fire dampers, setting sound attenuators, etc)
#37	Air Terminals (grilles, registers, etc)
#38	Setting Equipment (after unloaded from truck)
#39	Equipment Room Duct Hookup (not setting sound attenuators)
#40	Hole Cutting
#41	Air Balance (taking readings, paperwork, adjusting dampers)
#42	Travel Time

Management Use of Shop Work Code Data

Use of shop work code numbers will provide:

1) Fabrication costs of straight duct joints.

2) Fabrication costs of fittings.

3) Fabrication costs of dampers, louvers, etc.

4) A decrease in lost motion in the shop by implementing explicit worker accountability time while in the shop.

5) Reasonable projection or influence of old or new equipment on production as related to return on investment for new types of equipment.

6) Elimination of lost time at starting, coffee breaks, lunch, etc through the use of a time clock and work codes. This could represent a considerable dollar amount on an annual basis.

7) Increased influence on the bidding process as real time feedback is returned to the estimating department through the effects of production variances.

8) Payroll costs (generated from time cards).

9) Labor reports (generated from time cards).

10) Reduction of amount of time spent by supervisors in time keeping and verification.

The management team must decide at the start of each large job that is ready for fabrication exactly to what extent the costs are to be monitored. This type of decision is normally made at the weekly staff meeting or at a special pre-job conference involving all departments to be working on the job.

Caution should be used so as not to spend time and money in collecting job data that is repetitious, inaccurate, or unduly expensive to formulate. Data gathering is expensive, so it pays to be very selective as to the timing and content of this process.

TYPE 1 DATA: A good deal of meaningful data can be accumulated by using the very basic shop work code numbers. This is the normal approach and the use of code numbers 20 -29 will provide data for the various types of work involved in the average job. This data will be of value primarily to estimating and payroll.

TYPE 2 DATA: Type 2 data will be formulated when work code numbers 23 - 25, followed by an alphabetic character (i.e. #23 C - Fitting Layout and Cutting), are used in conjunction with specific units of work over time spans of less than two hours. The purpose of Type 2 Data is to provide information to reflect the cost of each work station as related to the total cost of the specific type of duct. The following example should clarify this application.

EXAMPLE: Suppose we need to know the effect of having a new beading machine installed in the shop. By processing several jobs through the shop and using work code #24 X to record the time consumed at this station, we can get a good idea of what the actual cross-breaking process is costing us at this time. We also know that the beading machine will be about four times faster than hand cross-breaking, so we can actually relate a rate of return dollar value on the expense of the new beading machine. An important function of this data is to provide insight as to exactly which pieces of equipment should be purchased first.

The ultimate benefit of using these numbers is to eventually obtain reasonably accurate costs for the various shop operations, while keeping the expense of recording these costs to an absolute minimum. These studies will be run in batches that consist of either fittings or straight duct, and at regular intervals. The data shuld be recapped on forms marked **Shop Fabrication Data** and then filed for future review. The pounds and gauge will also be entered on the log of time studies entitled **Fittings Fabrication (Batch)** or **Straight Duct Fabrication (Batch)**. The purpose of the logs of time studies is to prompt us to utilize time studies in a variety of applications.

The routine for doing a time study for Type 2 data should be as follows:

- Select a batch of fittings or straight duct and note the pounds and gauge. This data is on the computer listing sheet. Refer to the log of time studies to ensure a variety of applications and avoid doing the same gauges repeatedly.
- Instruct the shop men to keep the target batch separate from other work.
- Shop men will punch the clock to record time started on the target operation. In the example below, a shop man would mark his time card:

Job#	Control Zone	Work Code	Clock Time
2286	1	24	8:00
(Not required to mark lunch)			12:00
			12:50
		24 X	1:18
		24	3:90
			4:50

From this time card, we know that the man worked from 1:18 until 3:90 (military time) on **24 X** (which is cross-breaking the target batch).

Deduct break times from time studies, as employees will not punch out at breaks and this would distort our numbers.

TYPE 3 DATA: Type 3 data is intended to reflect the fabrication costs of one unique type of fitting as related to other unique types. This data is also relative to the quantity of each type that is fabricated at one time. For example, the detailer needs to know if a radius elbow is less expensive than a vaned elbow with square heel and throat.

By knowing the actual fabrication costs of the various fittings, we can design our job efficiently. Also, by knowing the actual fabrication costs we can function in areas such as piece estimating, which is the most advantageous estimating approach available at this time.

This type of data will also give us an insight as to the influence of producing more than one given type of fitting at a time, as well as the relationship of the heavier or lighter gauges of metal being used.

The procedure for a time study to produce Type 3 data is as follows:

- Refer to the log of time studies to determine what specific type of fitting has the least entries on the log. When this type is to be fabricated, then the study should be made. We are interested in gathering data on:
  - the specific type of fitting (F1, F2, F3, F4, etc);
  - various quantities of each type (1 thus, 2-6, over 6); and

  - various gauges of each type (with and without standing seams)

- When one or more of the type fittings that need to be studied are ready to be made in the shop, fill out a form marked **Shop Fabrication Data**.
- Convert into a small individual job by adding the fitting type as a prefix to the regular job number. This will enable each man working on this duct to punch in on this small job and will thus keep the time spent working on it separate from the regular job number. For example, to do a time study on an F7 Radius Offset for Job 2296, the job number would appear as **F72296**.
- At the completion of the piece(s), the time spent should be entered on both the **Shop Fabrication Data** sheet and the log of time studies.

Management Usage of Field Work Code Numbers

Erection Cost Control

By separating larger jobs into control zones, it will enable the cost of each zone to be taken to strengthen any problem areas.

The job foreman should keep accurate time records on each work code number used by each man every day. These should be called in daily, whenever possible. The information called in should consist of **job number, worker's name, control zone worked on, field work code number,** and **length of time spent on each work code number.** These numbers can be compared back to the original estimate at the conclusion of each zone.

The 14 field work codes will provide good feedback from the field labor, to satisfy both estimating and payroll requirements. On Page 45 is a suggested format for listing the data relative to this process.

It should be decided at the weekly staff meeting or at a pre-job conference exactly which field work codes will be used. These codes should be typed up and given to the sheetmetal superintendent, to be passed on to the job foreman (along with any special instructions about timekeeping). The time will be reported by job number, control zone, and work code number.

At this point you have three options:

OPTION 1: Assign someone to record and update labor at given intervals (i.e. labor report weekly or bi-monthly).

OPTION 2: Forward the labor data directly to the estimator (this would be a weekly copy of the format on Page 45 as it is turned in weekly for payroll). With this information, the estimator need only to concern himself with specific data relative to the feedback required, as determined earlier.

OPTION 3: Implement a computer program to generate a weekly labor report and job cost relating dollars estimated to dollars spent under selected work codes. Payroll would be generated from this input, also. The input would be the standard format shown on Page 45.

Daily Field Time Sheets

Time Sheet Headings

Name	Date	Job #	Work Code	Hrs.	Control Area		Comments
					Area ID	%Compl.	

Application Instructions

Note: Provide pads of these to field foremen.

1) Foremen will fill out one each day for themselves and each man on the job.

2) Foremen will use these sheets to call in or send in time (daily). All sheets should be sent to shop as soon as possible, even if time is called in.

3) **% Complete** column will normally only be used when a specific work code associated with a zone is 100% complete. At that point, **100%** will be entered for the associated work code in the given area.

Name	Date	Job #	Work Code	Hrs.	Control Area		Comments
					Area ID	%Compl.	
J.D. Smith	3/7/88	2296	32	6	A1	100	
	3/7/88	2296	33	2	A1		

4) If for any reason a work code on a given zone is started but cannot be completed due to an unexpected delay (of several days), the **% Compl** column would be filled in with an estimate and the **Comments** column with an explanation of the delay.

Equipment Performance On Shop Fabrication

Job Name

Straight Duct or Fitting (F#) Type Total Wt _____

Note: Quantity
(1 THUS)
(2-6)
(Over 6)
Gauge

Type of Connectors (S & D, etc) __________
Seams (Pitts, Snap-Lock)
Were Standing Seams used? ____YES ____NO

Time Studies (Hrs or Min)

(S) Shearing __________
(N) Notching (straight duct) __________
(C) Cutting (fittings) __________
(B) Bending straight duct __________
(DC) Ductliner (cutting) __________
(DA) Ductliner (applying) __________
(A) Assembly (shop or job) __________
(V) Turning vane fabrication __________
(X) Cross-breaking __________
(F) Form fitting and edges __________
(CN) Straight duct connector ends (drives) __________
(E) Straight duct edges (pitts/snap-lock) __________

Need to check several sizes of straight duct

Need time studies for 1 THUS
2-6
over 6

Shop Arrangement & Material Storage

General Characteristics

- Good lighting
- Dock level truck loading
- Aisleways painted, maintained, strategically located, adequate in size
- Safe
- Flexible (systems, equipment and personnel, overhead electrical)
- Efficient doors
- Well-ventilated
- Noise-controlled
- Business-like atmosphere
- Public Address system

Information from the IES Lighting Handbook

Area	**Footcandles on Tasks**	**Dukalux # on Tasks**
Sheet Metal Works		
Miscellaneous machines, ordinary bench work	50	54
Presses, shears, stamps, spinning, medium bench work	50	54
Punches	50	54

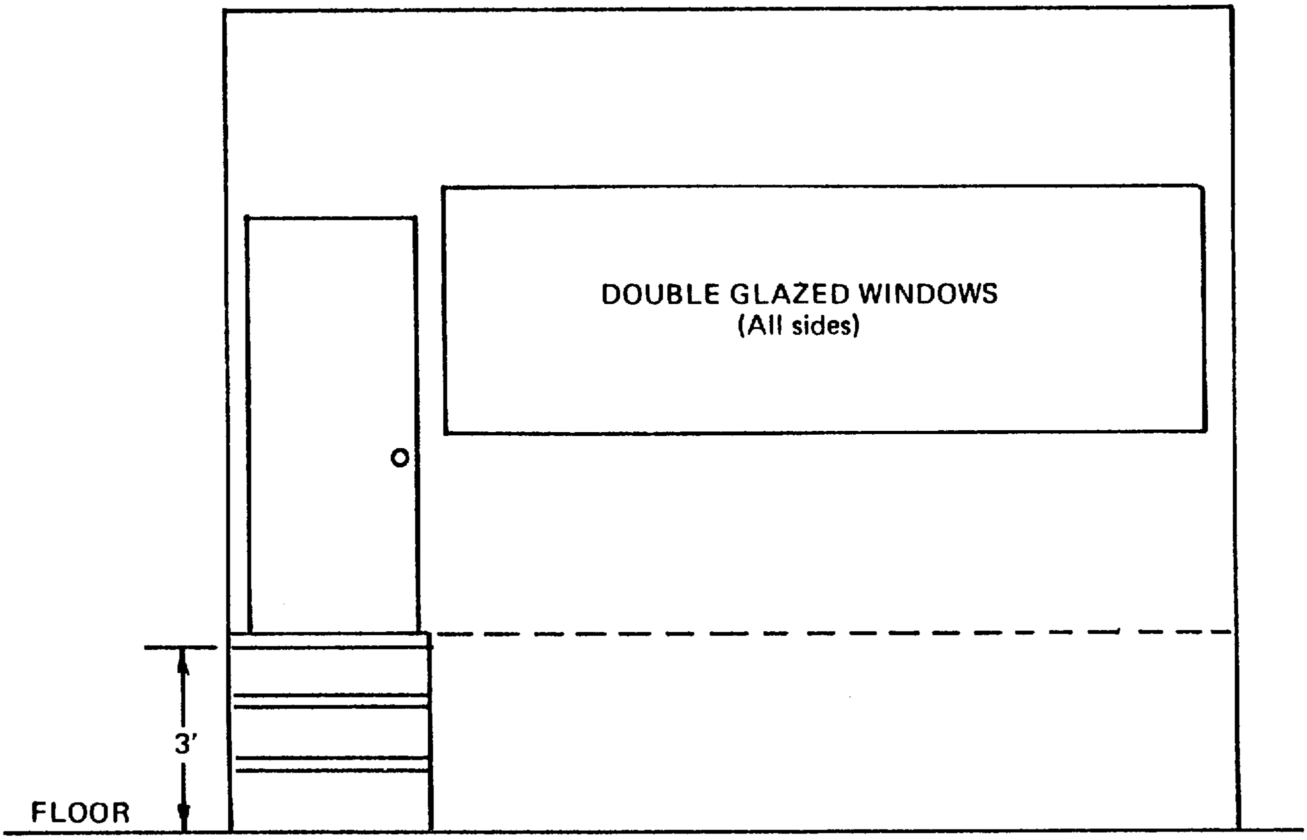
Area	**Footcandles on Tasks**	**Dukalux # on Tasks**
Tin plate inspection, galvanized	200	220
Scribing	200	220

Aircraft Manufacturing (from IES Lighting Handbook)

Area	**Footcandles on Tasks**	**Dukalux # on Tasks**
Stock parts		
Production	100	110
Inspection	200	220
Parts manufacturing		
Drilling, riveting, screw fastening	70	75
Spray booths	100	110
Sheet aluminum layout and template work, shaping, and smoothing of small parts for fuselage, wing sections, cowling, etc	100	110
Welding		
General illumination	50	54
Precision manual arc welding	1000	1080
Subassembly		
Landing gear, fuselage, wing sections, cowling, and other large units	100	110

Shop Office Characteristics

- Elevated floor
- Double-glazed windows
- Strategically located
- Sound proof
- Comfortable
- Effective document management (clipboard rotation and filing system)
- Clean and orderly
- Well-lighted

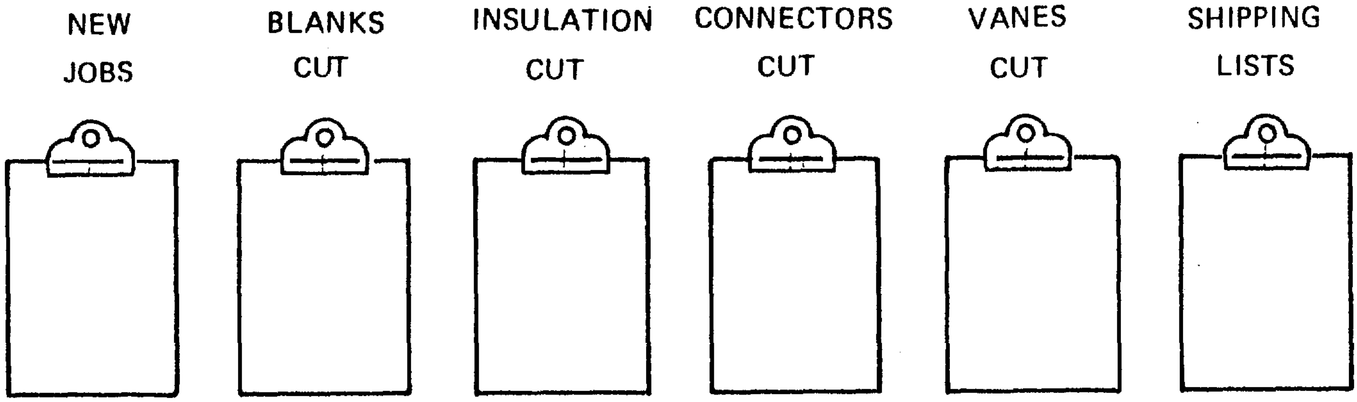


CEILING AND WALL CONSTRUCTION TO BE DOUBLE LAYERS OF ¾" SHEETROCK OR MASONARY.

SHOP OFFICE

(Sound Proof)

FIGURE 50



CLIP BOARD ROTATION

FIGURE 51

Shearing Operation

- Capacity margin
- Type (mechanical/hyd)
- Width
- Back gauge
- Front squaring arm
- Light bar
- Location of shear
- Location of material
- Scrap removal

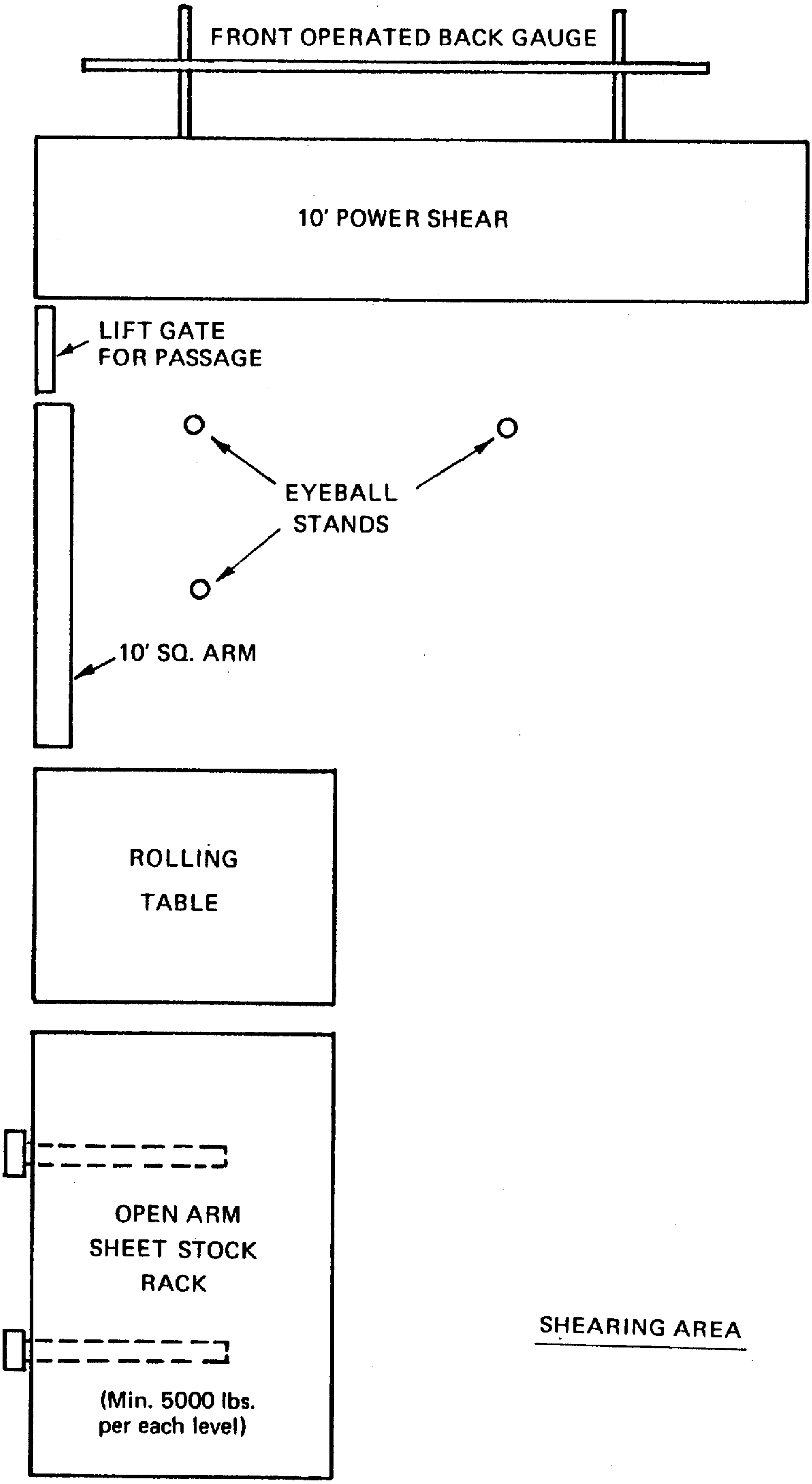

FRONT OPERATED BACK GAUGE
10' POWER SHEAR
LIFT GATE FOR PASSAGE
EYEBALL STANDS
10' SQ. ARM
ROLLING TABLE
OPEN ARM SHEET STOCK RACK
(Min. 5000 lbs. per each level)
SHEARING AREA

FIGURE 53

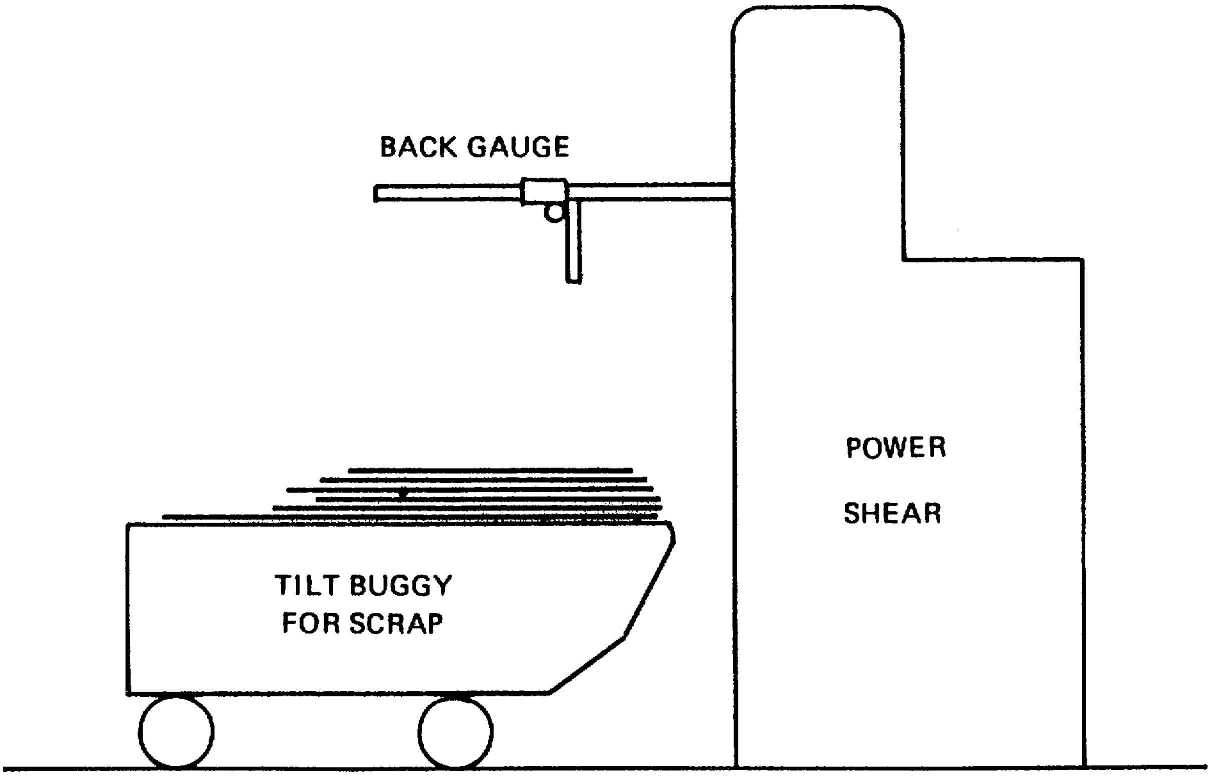
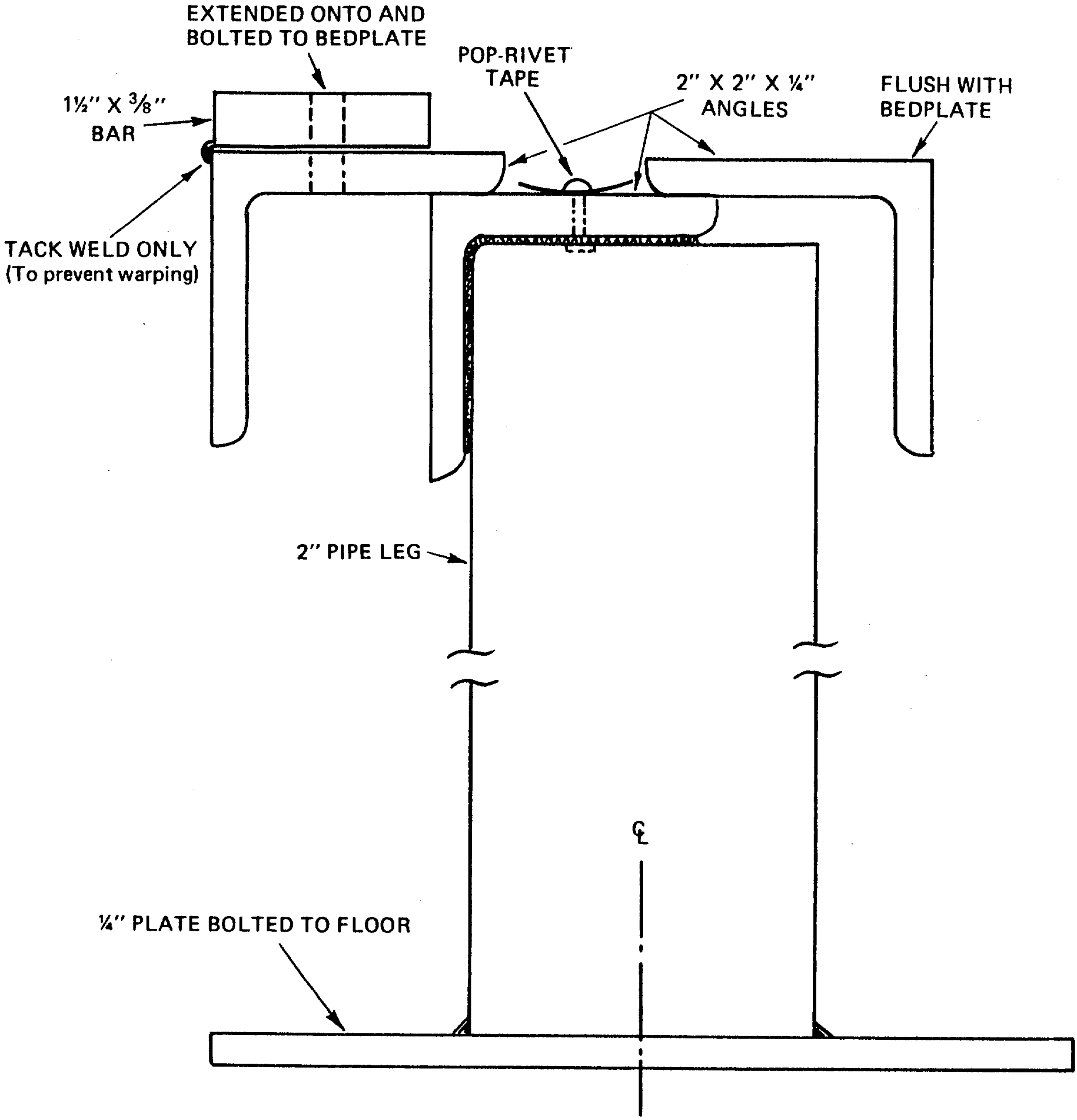


FIGURE 54

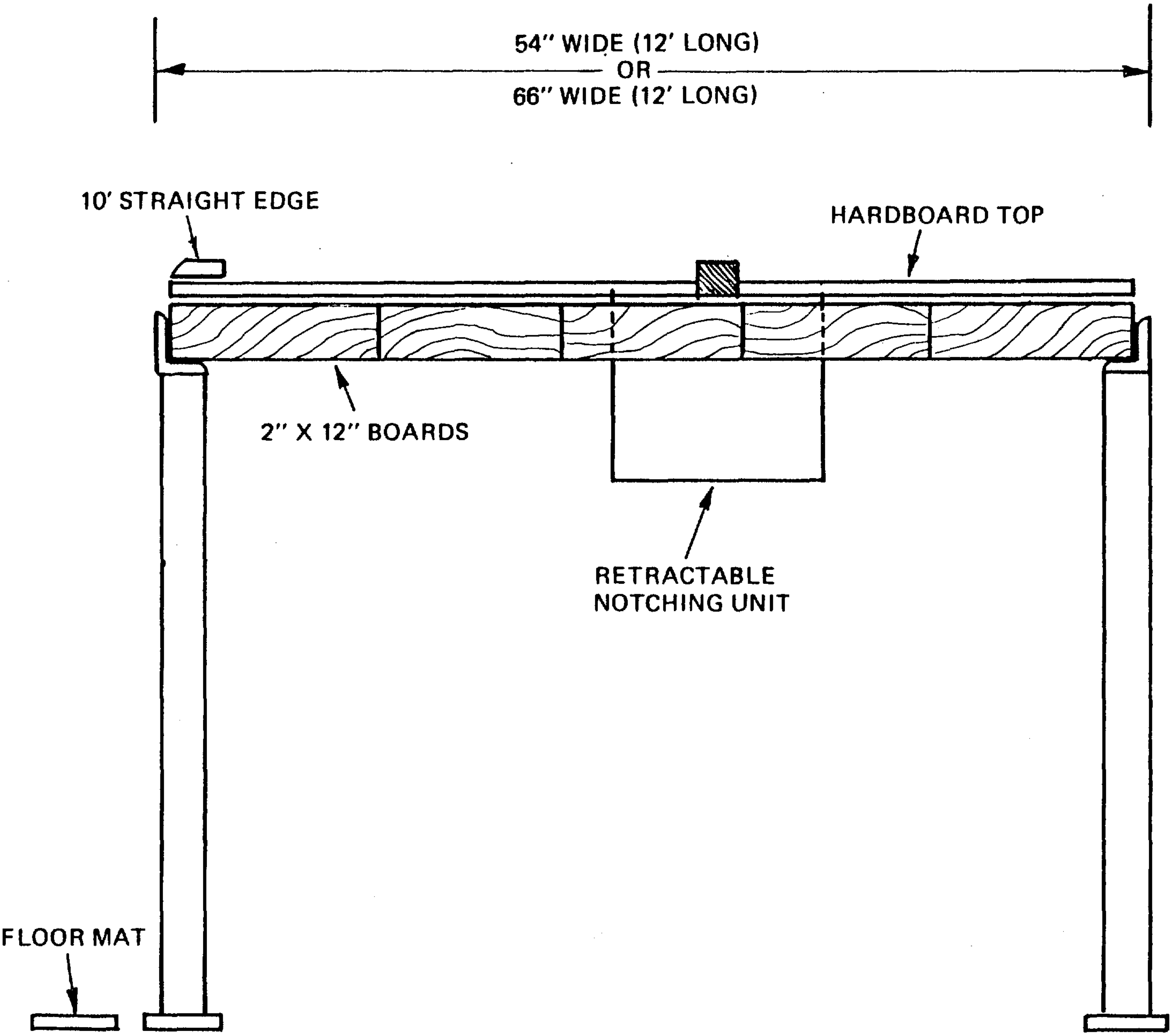


SHOP FABRICATED 60" SQUARING ARM FOR SMALL SHEAR

FIGURE 55

Fitting Layout Benches

- Location
- Design
- Quantity
- Lighting
- Arrangement



WORK BENCH DESIGN

FIGURE 57

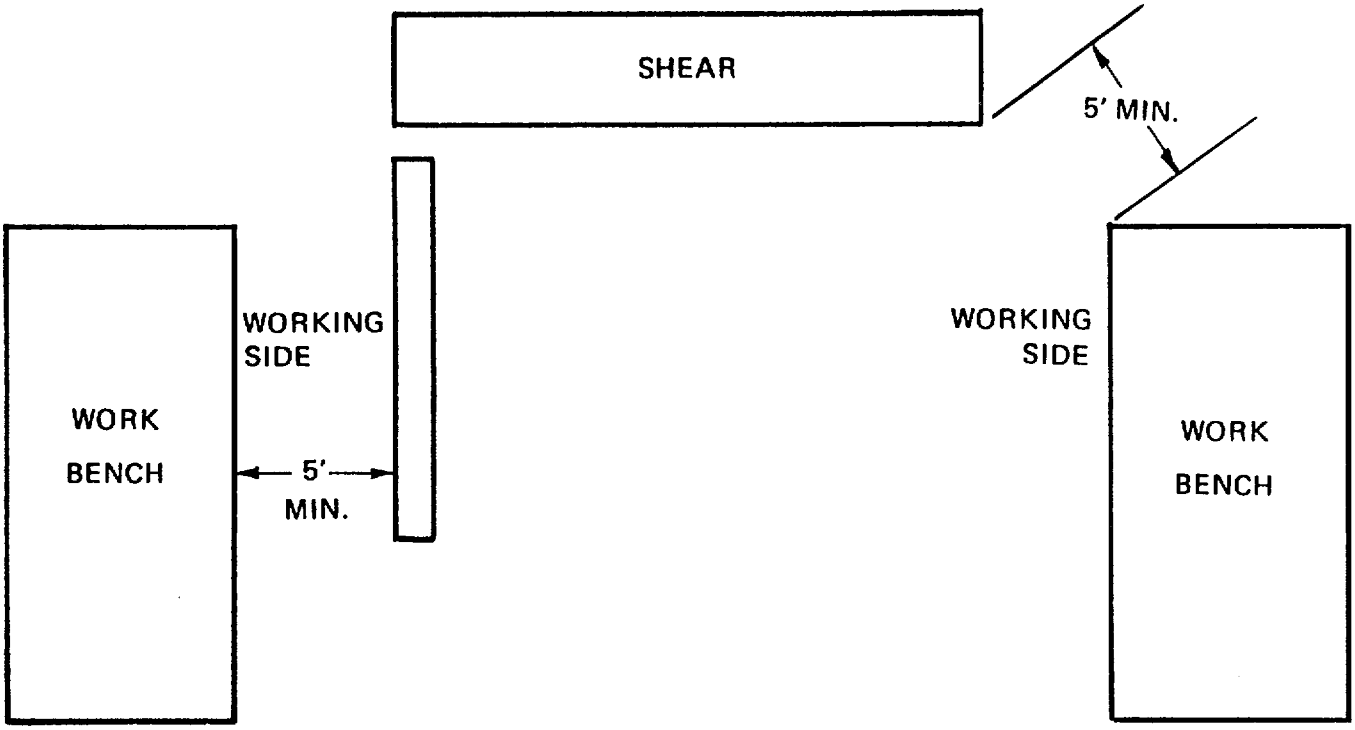
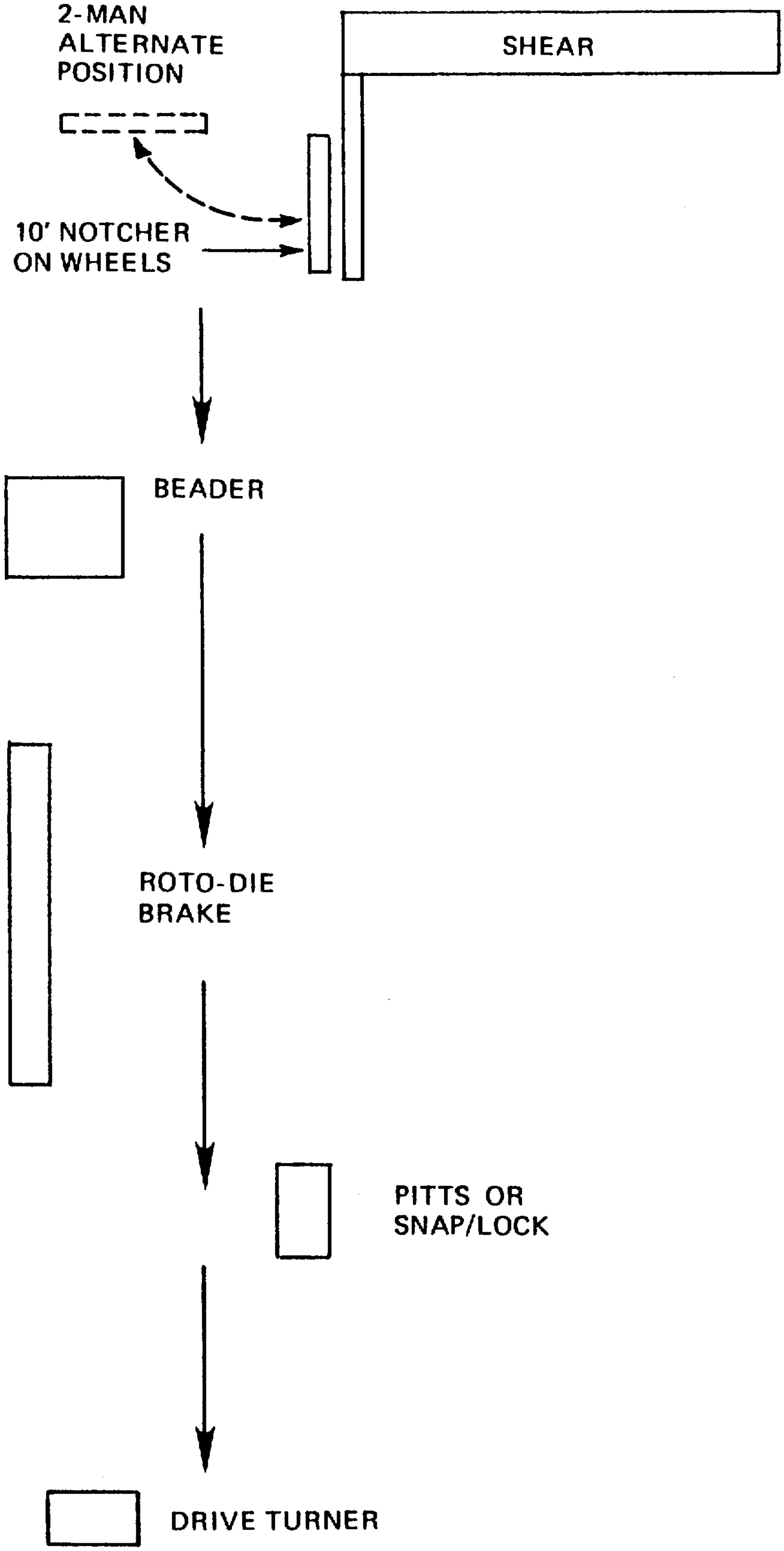

SHEAR
5' MIN.
WORKING SIDE
WORK BENCH
5' MIN.
WORKING SIDE
WORK BENCH

FIGURE 58

Forming Areas

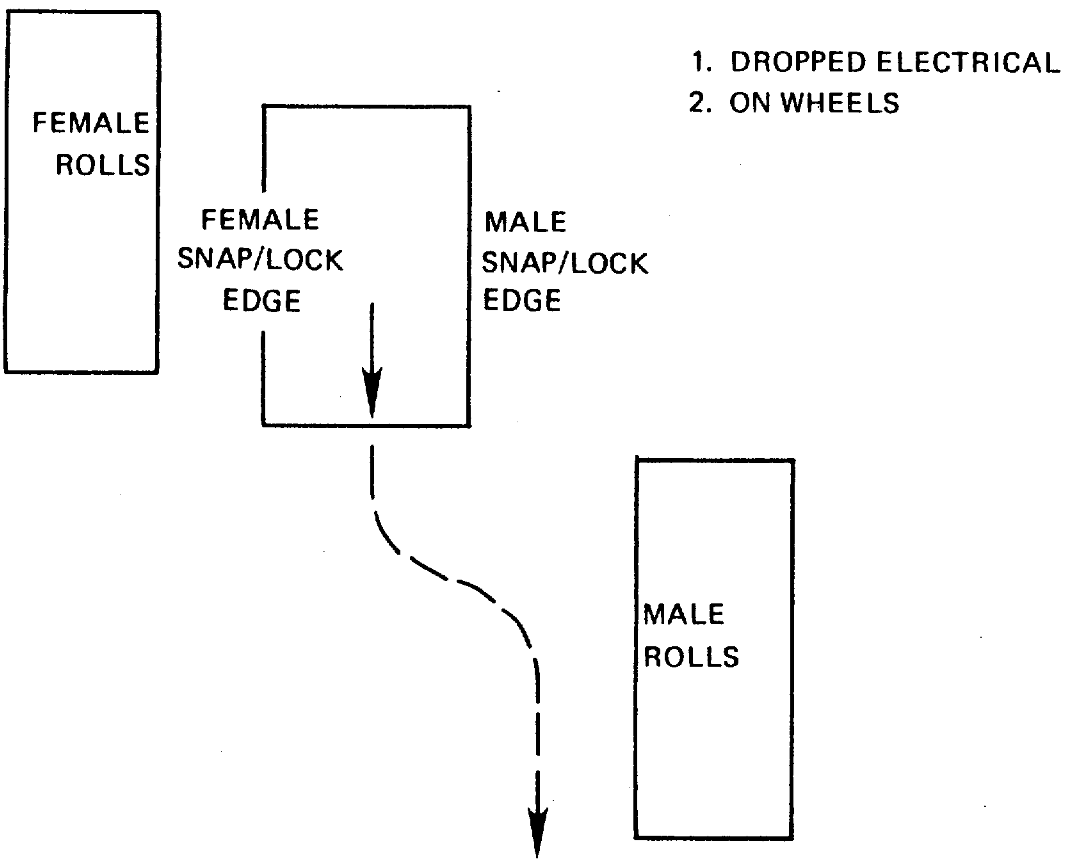
- Straight duct joints (non-coil line)
- Fittings
- Welded ductwork

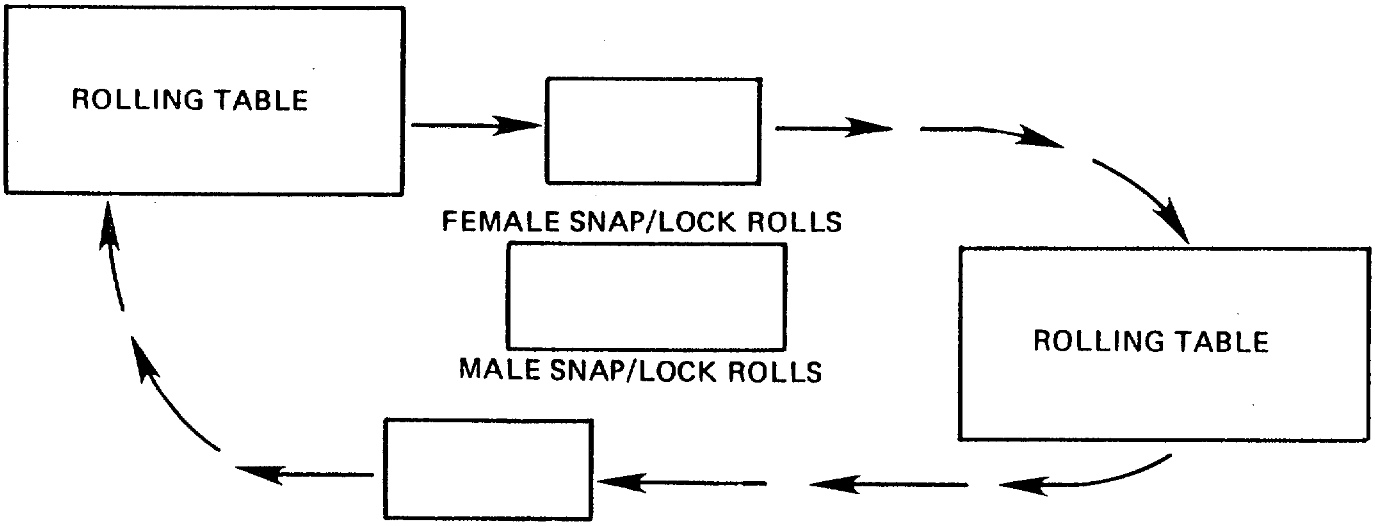


STRAIGHT DUCT (FULL) JOINTS

FIGURE 60

ROLLFORMING AREA


1. DROPPED ELECTRICAL
2. ON WHEELS

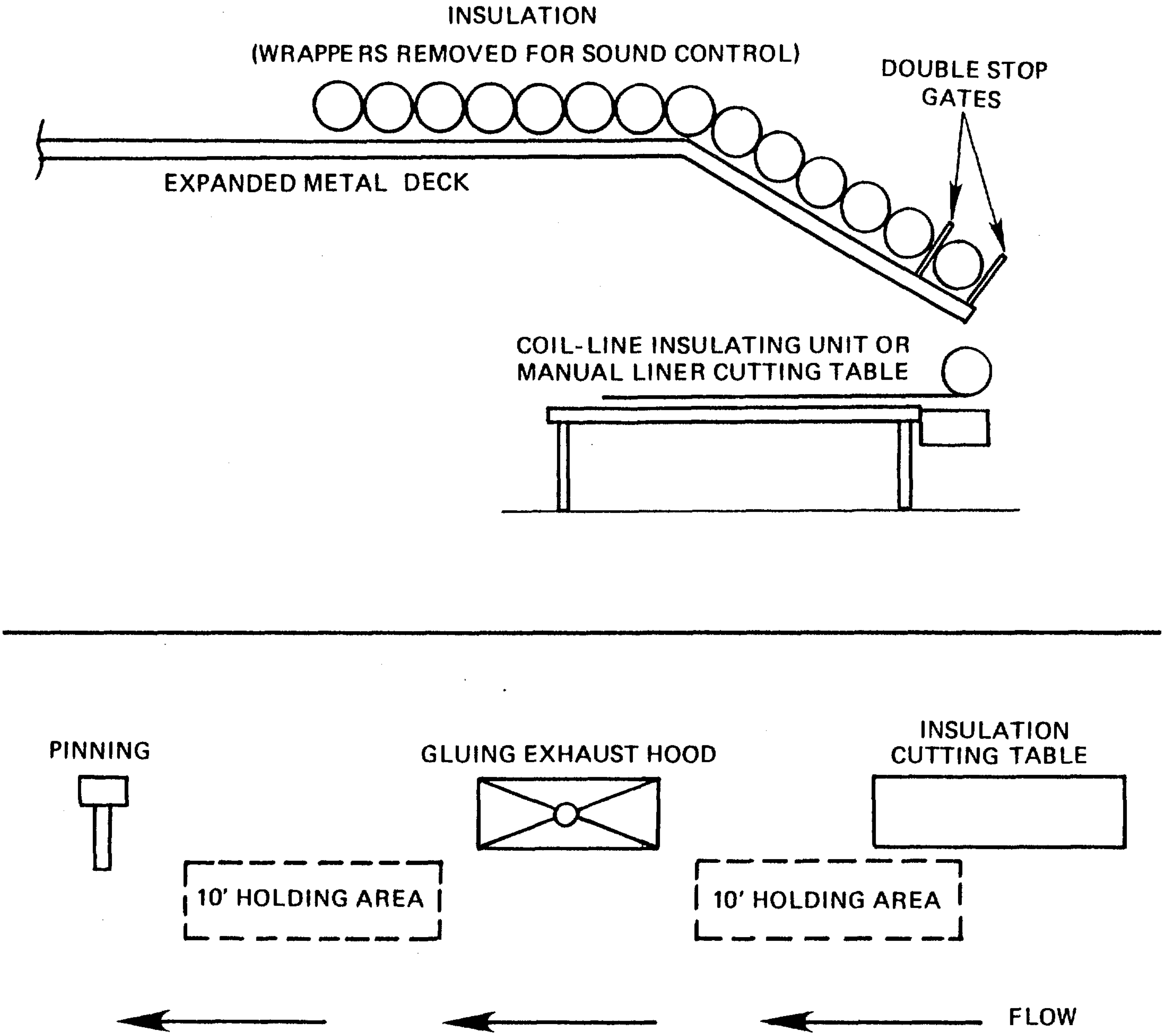


SINGLE MACHINE REVERSIBLE MOTOR

FIGURE 61

Ductlining

- Storage
- Cutting
- Gluing
- Pinning



INSULATING AREA

FIGURE 63

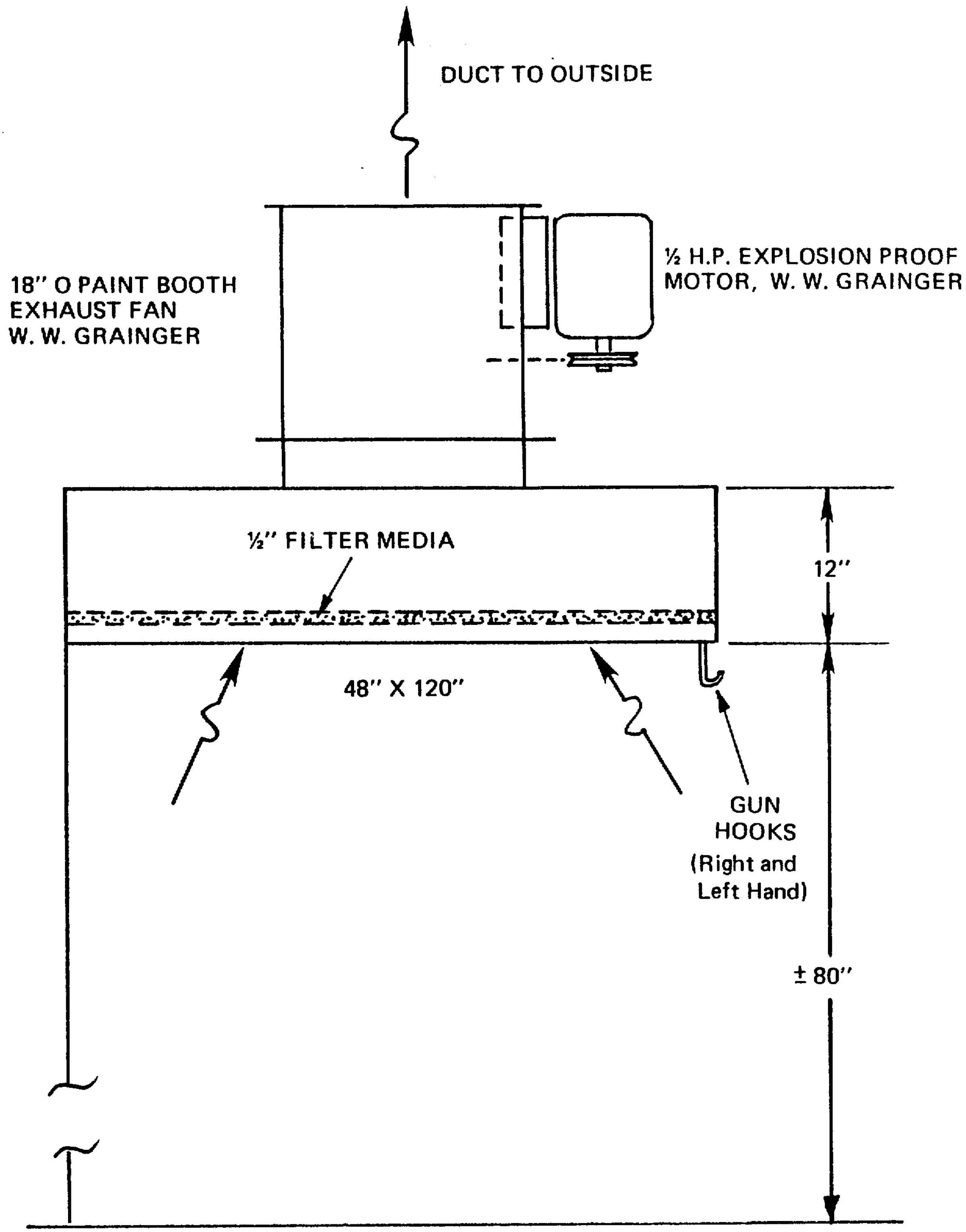
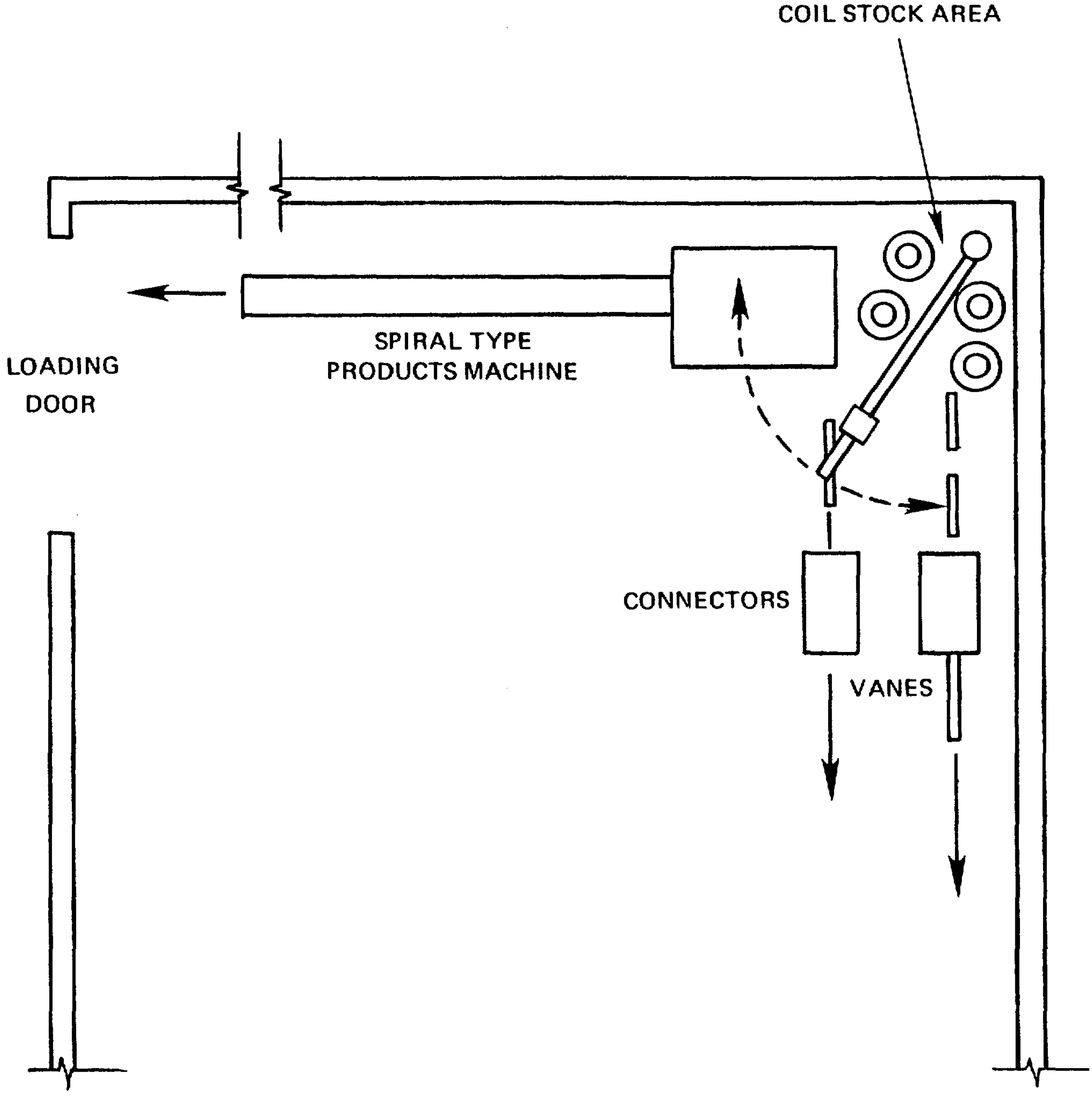

DUCT TO OUTSIDE
18" O PAINT BOOTH
EXHAUST FAN
W. W. GRAINGER
½ H.P. EXPLOSION PROOF
MOTOR, W. W. GRAINGER
½" FILTER MEDIA
12"
48" X 120"
GUN
HOOKS
(Right and
Left Hand)
± 80"

FIGURE 64

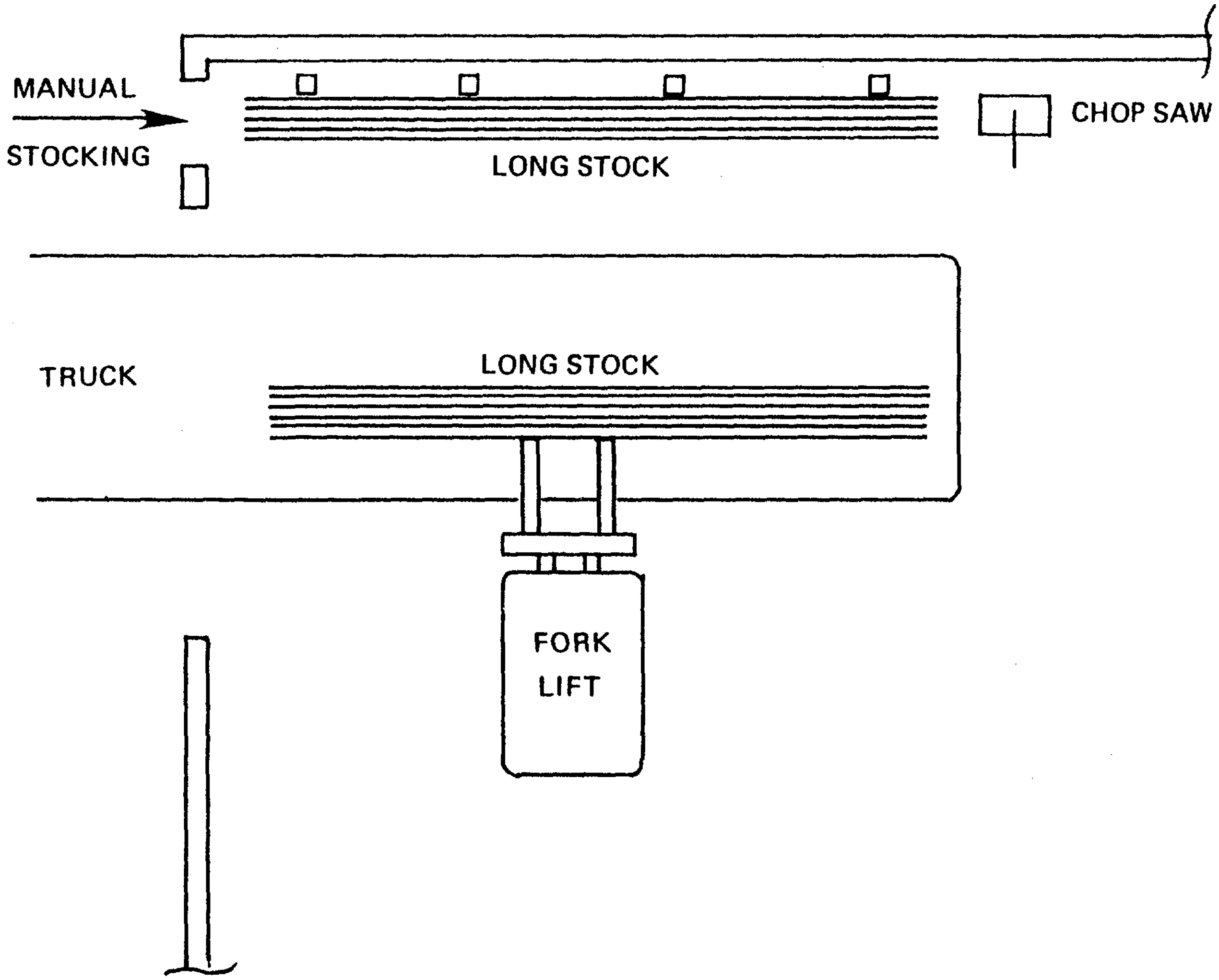
Vanes/Connectors

- Stock Storage Location
  - The vane and connector stock should be located near the assembly area.
- Standardization
  - Company standards should be formulated and distributed to all employees to be used as guidelines for ordering duct.. The standards should reflect your most economical type of connector as first choice.
  - Factors in connector selection are **available connector fabrication equipment, individual job specifications and conditions,** and **availability for purchase.**
- General Concepts
  - Both vane and connector stock can normally be purchased from specialty vendors more cost-effectively than it can be fabricated in most shops.
  - The concept of providing connectors from drop-off material using lower cost labor should be carefully analyzed, with consideration given to such important aspects as the availability of a sufficient quantity of drop-off material of each gauge, when required, and the possibility of utilizing the worker on a more profitable type of shop work.



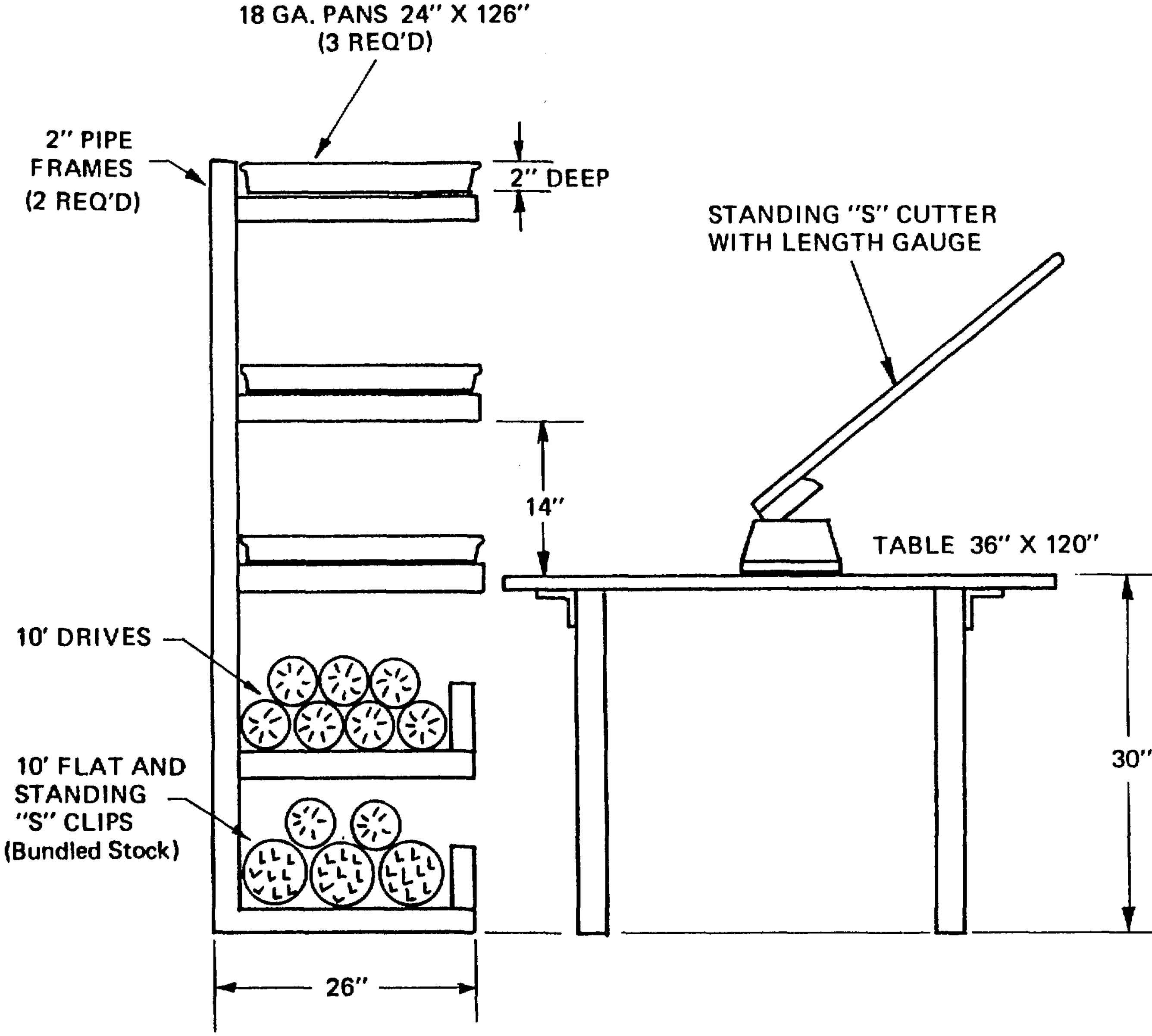
MULTI-USE JIB CRANE

FIGURE 66



LONG STOCK STORAGE

FIGURE 67

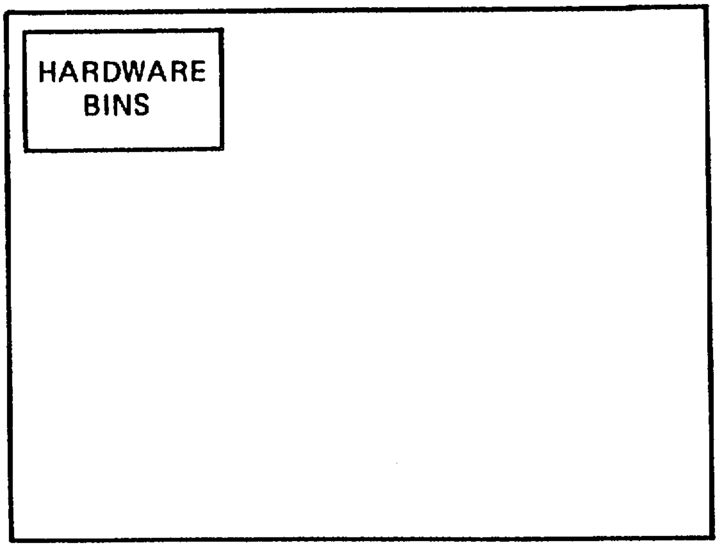


CONNECTOR RACK AND TABLE

FIGURE 68

Assembly Area

- Location
  - The assembly area should always be located near the shipping area and should be implemented with forethought and deliberation.
- Assembly Table Design
  - The assembly table should be constructed with several important and specific attributes in mind. The **work surface** should be no higher than 24" above the floor. The **top surface** should be made of a non-metallic material, such as wood, to reduce the slipping of fitting parts during assembly (this also will muffle hammer noise). A **"floating" multi-tiered parts tray** should reside on or near the table to hold miscellaneous damper hardware, long screws for vanes, etc.
- Tool Requirements
  - The basic assembly tools required include a **Pittsburgh air hammer, air or electric drills,** and any **tools required for special products assembly.**



1. APPROX. 72" X 72"
2. 24" HIGH
3. WOODEN TOP
4. HANG AIR AND ELECTRICAL
5. DAMPER HARDWARE IN CORNER
6. ON WHEELS IF REQUIRED

NEAR VANES
FABRICATION
AREA

NEAR CONNECTOR
FABRICATION
AREA

ASSEMBLY TABLE

(NEAR SHIPPING AREA)

FIGURE 70

Basic Rules for Shop Flow Path Layout

- Analyze each shop operation (shearing, forming, ductlining, assembly, welding, etc.) and arrange them for maximum internal efficiency as indicated in this manual.

REMEMBER: The key in shop layout is simply to eliminate footsteps!

- Locate the raw material storage area. Generally, the raw materials (flat sheets or coils) are best located deep within the shop area, enabling each fabrication operation to move the product closer to the loading area. This is why a long narrow shop lays out well.
- Locate the shop office in a logical area where the shop foremam can see and quickly get to most areas of the shop, with priority given to the areas requiring a higher level of communication (such as shearing, layout [or plasma table], coil-line, and shipping area).
- Layout dedicated aisleways, clean the floor thoroughly, and paint aisleways with a durable parking lot striping paint to produce a 3-4" wide stripe. Yellow paint should be used, to indicate caution for rolling tables, forklifts, etc. If you are using 48" wide sheets or coils, the aisleways should be painted 48" wide O.D. (minimum). If you are using 60" wide sheets or coils, the aisleways should be painted 60" wide O.D. (minimum). Establish a house rule that nothing will be placed in the aisleway that is not on wheels; even wheeled items should be placed outside the aisleway when possible. **The key to an efficient aisleway is simplicity.**

SPECIAL NOTE: All shops have aisleways. The difference is that in most shops, the aisleway layout is not defined and changes constantly, resulting in a less efficient flow path. This layout problem can prove to be very expensive if not adjusted.

General Tips for Shop Layout

1) Clean up the shop and remove unused materials and equipment.

2) Paint walls and ceiling a light color.

3) Add lighting if necessary (a minimum lighting level of 250 Dukalux is standard).

4) Add doors if beneficial for cross-ventilation, light, or to shorten the work flow path for loading.

5) Install a public address system from the shop office in larger shops.

6) Install a programmable buzzer system to signal start/stop activities.

7) Add skylights to reduce lighting energy load.

8) Hang safety signs in several locations.

9) Install a suggestion box.

10) Install an intercom system to key shop personnel.

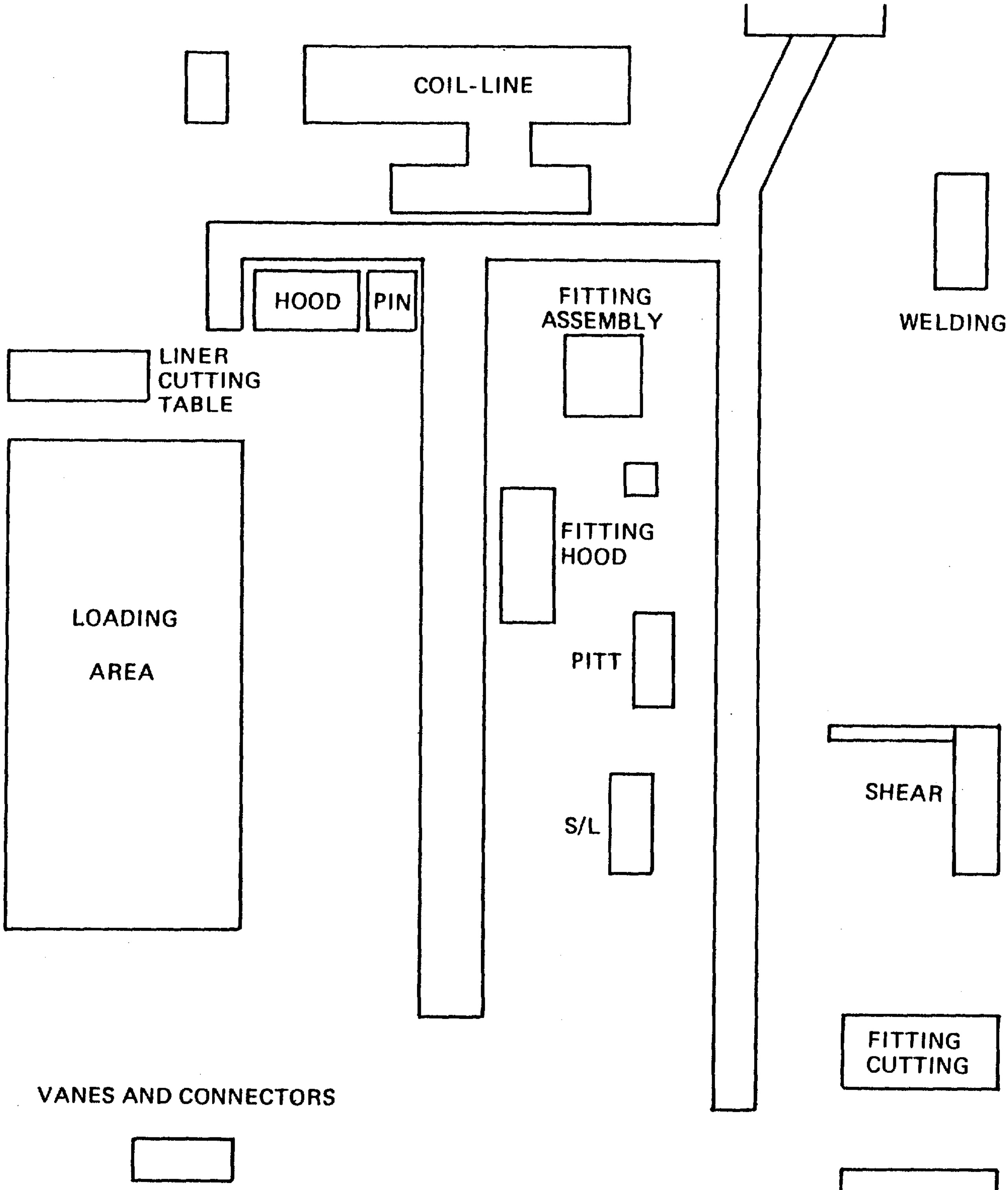

COIL-LINE
HOOD
PIN
LINER CUTTING TABLE
FITTING ASSEMBLY
WELDING
LOADING AREA
FITTING HOOD
PITT
S/L
SHEAR
FITTING CUTTING
VANES AND CONNECTORS

FIGURE 72

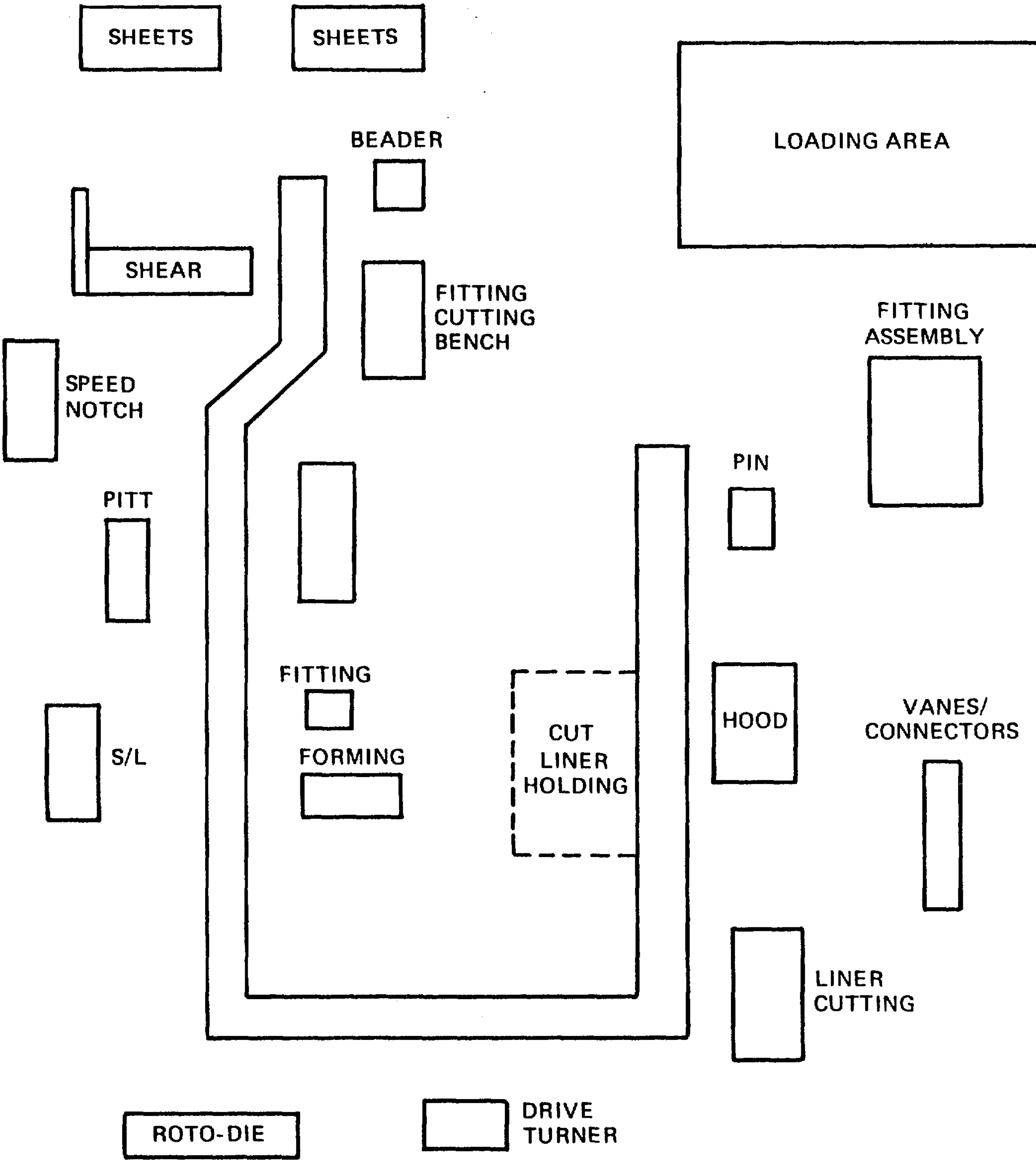

SHEETS
SHEETS
LOADING AREA
BEADER
SHEAR
FITTING CUTTING BENCH
FITTING ASSEMBLY
SPEED NOTCH
PIN
PITT
FITTING
HOOD
VANES/ CONNECTORS
S/L
CUT LINER HOLDING
FORMING
LINER CUTTING
ROTO-DIE
DRIVE TURNER

FIGURE 73

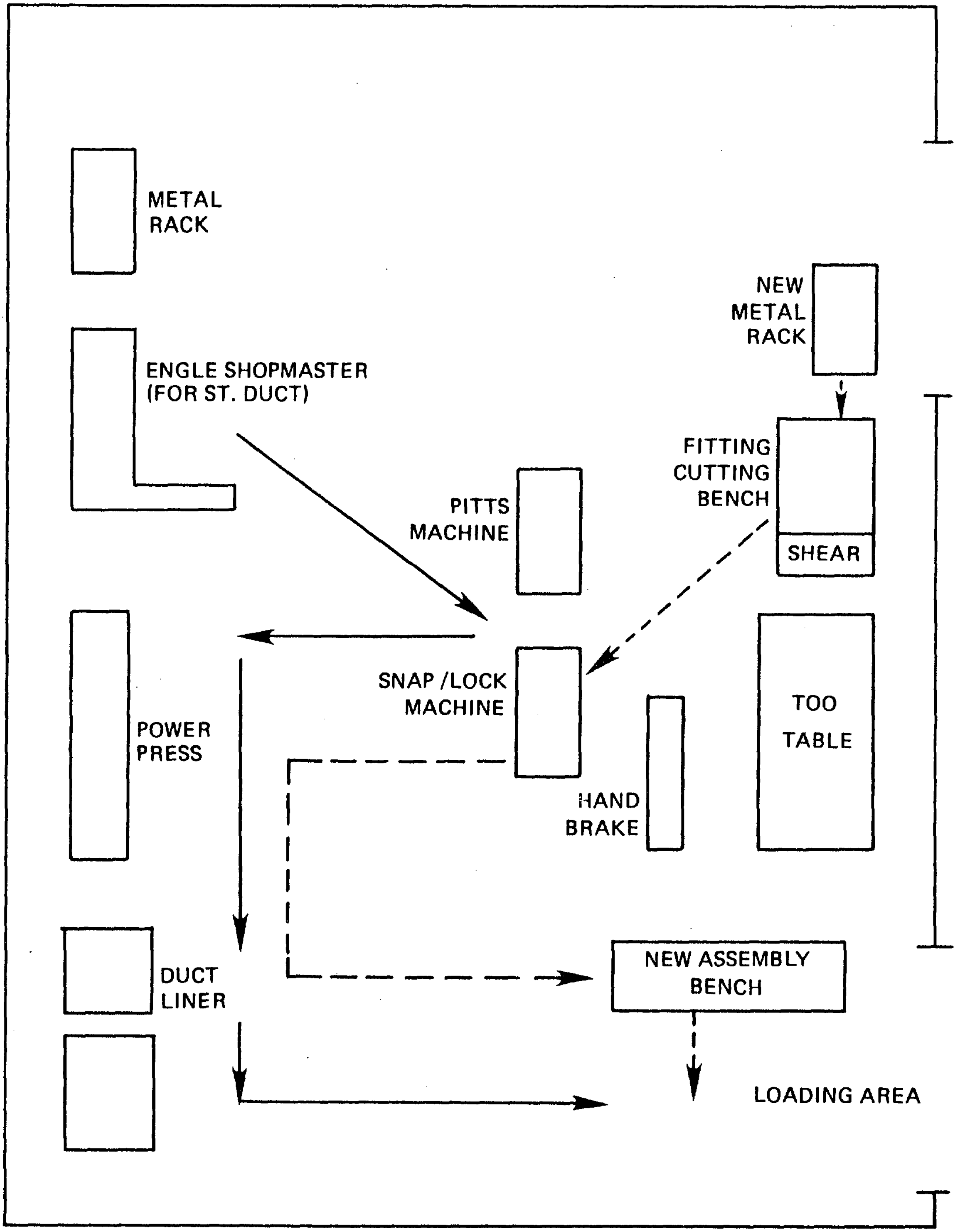

METAL RACK
NEW METAL RACK
ENGLE SHOPMASTER (FOR ST. DUCT)
FITTING CUTTING BENCH
SHEAR
PITTS MACHINE
POWER PRESS
SNAP /LOCK MACHINE
TOO TABLE
HAND BRAKE
NEW ASSEMBLY BENCH
DUCT LINER
LOADING AREA

FIGURE 74

Notes